Report to the

Pacific Salmon Commission

Data and Programs for the Transboundary Stikine, Taku, and Alsek Rivers Needed to Implement the Pacific Salmon Treaty

Regional Informational Report. 1J89-09

Alaska Department of Fish and Game
Division of Commercial Fisheries
Juneau, Alaska

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DATA AND PROGRAMS FOR THE TRANSBOUNDARY STIKINE, TAKU AND ALSEK RIVERS NEEDED TO IMPLEMENT THE PACIFIC SALMON TREATY

By

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[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uniterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

FOREWORD

This report presents a research plan that is based on activities of the Transboundary Technical Committee and the responsible management agencies. The authors have all been active in the work of the Transboundary Technical Committee, the senior author being the U.S. section chair of that committee. The authors are also employed by the Alaska Department of Fish and Game, and as such department policies are reflected. The report takes into consideration bilateral actions and discussions but has not been reviewed before publication by the Canadian section. This work was supported with U.S.-Canada Pacific Salmon Treaty funds, under Cooperative Agreement NA-88-ABH-00045.

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ABSTRACT

Comprehensive planning of research programs is needed if long-term information goals are to be realized. This document represents the initial efforts to develop a long-term research plan for the transboundary Stikine, Taku, and Alsek Rivers that would provide the information essential to upholding the Pacific Salmon Treaty and the long-term goals stated therein. These goals include providing for optimum salmon production and providing each Party to the Treaty with the benefits equivalent to production within its waters.

The planning process began with a detailed review of the Pacific Salmon Treaty to identify information and program needs for the transboundary rivers. Past planning efforts conducted by the Transboundary Technical Committee and by the Commission were then reviewed and results were synthesized. The types of information needed were identified and consisted of four basic elements: run reconstruction, fisheries management, information management, and enhancement. This framework was used to present a synopsis of the status of information on transboundary river stocks, fisheries, and research and monitoring programs, including identification of gaps in information and programs. A prioritized list of the most critical information needs for each of the transboundary rivers was then developed.

Additional information needs for each of the transboundary rivers identified in this work centered largely on chinook and coho salmon. Improving or developing escapement estimation techniques and marine catch accounting programs for both species generally received the highest priorities. Other information needs, including developing escapement estimates for chum salmon in the Taku River and improving escapement estimates for sockeye salmon in the Alsek River, were rated as medium priorities. Estimated costs of modifying existing programs or developing new projects to fill these information gaps vary considerably. Technology exists to improve estimates of escapement to the transboundary rivers; however, some of the methods are extremely expensive. Stock identification methods for monitoring harvests of chinook and coho salmon stocks in marine fisheries are not currently well developed and may be expensive to implement depending on the method chosen. Several generic issues of importance to all transboundary rivers were identified. Development of an on-line information system to allow joint access to available data bases needed to manage fisheries was given a high priority, as were providing additional biometric assistance to managers in developing new management systems and developing an effective mass-marking technique for identifying returns from enhancement projects.

INTRODUCTION

Rigorous planning of the programs that provide information to the Pacific Salmon Commission is critical if the long-term goals established by the Pacific Salmon Treaty[1] are to be realized. These goals, as identified in Article III Paragraph 1 of the Treaty, include providing optimum salmon production and providing for each Party benefits equivalent to the salmon production originating in its waters. In Paragraph 2 of the same article, the Treaty recognizes the need for cooperation between the Parties in management, research, and enhancement. To date, data collection and program planning have been undertaken by the responsible management agencies, through inter-agency discussions within national sections, within the Technical Committees, and by the Commission through a contract study with Shepard and Alverson (NRC 1986). In addition, a process for developing a Commission plan is being generated by the Research and Statistics Committee.

Herein we present a research plan specifically for the transboundary Stikine, Taku, and Alsek Rivers. This plan embodies both the recommendations of Shepard and Alverson (NRC 1986) and previous work of responsible management agencies and the Transboundary Technical Committee (TTC). Our report is presented in five chapters and a brief discussion of each chapter is presented below.

In chapter one, we review the Treaty, Treaty Annex IV, and Understandings for the purposes of identifying information and program needs for the transboundary rivers. The language of the Treaty and Annex is often very general and, therefore, subject to interpretation. We have attempted to remain objective, however the interpretations given are our own. Recognizing that differences in interpretation between the Parties are possible, Commission review of any such interpretation would be necessary before it would be used bilaterally.

In the second chapter, we review and synthesize existing information on planning and the planning process. The two sources we reviewed were a report prepared by Shepard and Alverson (NRC 1986) on technical information needs of the Commission, including those for the transboundary rivers, and reports of the TTC.

In chapter three, we develop an explicit framework of the types of information and programs needed for the transboundary rivers that are relevant to the Commission.

In chapter four, we present is a synopsis of the status of stocks, fisheries, and research and monitoring programs from the transboundary rivers based on the framework developed in chapter three. This synopsis describes the program status and current knowledge as of the spring of 1989. We hope this synopsis will assist those who are unfamiliar with the pertinent issues in understanding how identified gaps in knowledge are addressed by the existing research and management programs.

In the last chapter, we present our evaluation of the relative importance of obtaining new information, refining existing information, or establishing new programs within the framework presented in chapter four. We also indicate how we would likely proceed to obtain the information or implement identified programs. This list is based on current status of information and annex provisions and is subject to revision with time.

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[1] Treaty Between the Government of the United States of America and the Government of Canada Concerning Pacific Salmon (entered into force, March 18, 1985).

CHAPTER 1
IDENTIFICATION OF INFORMATION NEEDS

Review and synthesis of the Treaty Articles, Annex IV, and Understandings permit identification of information and programs required by the Commission to implement the Pacific Salmon Treaty. Abstracts of information and program needs as identified by the Treaty are presented here. Interpretative commentary follows each abstract when appropriate. Within the Treaty, Annex, and Understandings, some information needs are restated several times. Multiple entries found during the sequential review of the Articles, Annex, and Understandings are not restated in this synthesis.

Article I - Scope

Abstract

Salmon stocks subject to the Pacific Salmon Treaty are those which originate in the waters of one Party and:

(a) are subject to interception by the other Party;
(b) affect the management of stocks of the other Party; or
(c) affect biologically the stocks of the other Party.

Commentary

In the Treaty the term stock is ambiguous and can be defined at many levels including: at the level of biological stocks, at an aggregated level which reflects contemporary management ability, or at a level which reflects Commission fishery regime Annex language. Different levels of interest are evident in the Treaty and reflect the different status of knowledge of the various stocks and fisheries and of the nature of fishing regimes that have been negotiated. Under some circumstances, Treaty level management and biological stock management are identical. This detailed level of stock interest is especially evident for the transboundary and Fraser rivers. To the extent that biological stocks can be and are managed in the fisheries of concern, it appears that the Commission desires information at the biological stock level. Therefore, identifying and developing opportunities for biological stock management becomes an underlying principle to guide research and program development efforts of the Parties for the transboundary rivers.

Article III - General Principles

Abstract

The first general obligation stated in the Treaty requires each Party to conduct its fisheries and enhancement programs so as to prevent overfishing and provide for optimum production. By Treaty definition (ref. Article I), overfishing means fishing patterns which result in escapements significantly less than those required to produce maximum sustainable yield (MSY).

The second general obligation requires each Party to conduct its fisheries and enhancement programs such that each Party receives benefits equivalent to production of salmon originating in its waters. In fulfilling their obligations pursuant to Article III, the Parties are required to take into account:

(a) the desirability in most cases of reducing interceptions;
(b) the desirability in most cases of avoiding undue disruption of existing fisheries; and
(c) annual variations in the abundance of the stocks.

Commentary

Four types of information are needed to implement the MSY principle. First is an estimate of the escapement required to produce MSY. Second is in-season knowledge of either total run size so that total allowable catch (TAC) can be determined or actual escapement-to-date so that escapement can be monitored for the optimal level. Third is knowledge of the contribution that a specific stock makes to catches in pertinent fisheries and of the impact that various fishing patterns and regulations have on that stock. Fourth is knowledge of the number of fish which actually comprise the annual escapement.

A prerequisite for determining if the second general obligation, referred to as the equity principle, is being met is an accounting of the number of salmon bound for each nation that are harvested by the other. While the Treaty obligation does not require accounting by individual stocks of origin, it is obvious that stock composition estimates made to fulfill obligations to manage for MSY would also provide the needed interception data.

Annual run reconstruction[2] programs designed to permit management for MSY provide the basic biological data needed to address issues (a) and (c). With regard to (b), avoidance of undue disruption to existing fisheries requires knowledge of the social and economic characteristics of the fleets which are intercepting stocks of the other Party. Issues of undue disruption rest solely with the Panels and Commission. While nothing precludes the Commission from requesting a study of these issues, unless and until specific directions emerge, we consider existing information sufficient.

Article IV - Conduct of Fisheries

Abstract

To facilitate implementation of the general principles (see Article III) and, specifically, to implement provisions pertaining to the transboundary and Fraser rivers, this Article establishes reporting procedures for the Parties. Two annual reports are to be provided to the Commission: a post-season review of the past year's fishing activities and a preseason management plan for the ensuing year.

No specific instructions are provided in Article IV about the contents of the postseason report. In regards to the preseason report, Article IV is specific; it requires the following information:

- (a) the estimated size of the run;
- (b) the interrelationship between stocks;
- (c) the spawning escapement required;
- (d) the estimated TAC;
- (e) each Party's intentions concerning management of fisheries in its own waters; and
- (f) its domestic allocation objectives whenever appropriate.

Commentary

The exact contents and format of these annual reports are the subject of ongoing bilateral discussions. One piece of requisite information which has been identified during these ongoing discussions is a summary of management performance relative to negotiated fishery regimes as specified in Annex IV. This information is already being provided by the TTC in its annual postseason report.

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[2] Run reconstruction is the process of determining total run size by adding estimated catches from pertinent fisheries to the escapement estimate. This usually involves stock composition estimation for the fisheries catches. The process often includes estimation of migratory timing and age and sex composition of the run.

In regards to the preseason report, a new general obligation of the Parties is to forecast the abundance of the next year's run. The purpose of this forecast is to permit estimation of the TAC. The preseason report should outline management intentions of each Party.

Forecasting can be approached in many ways, but is usually done by relating the abundance of the adult return in one year and the abundance of the same cohort in an earlier year in the life cycle. Data typically used to forecast include: catches, spawning escapement, egg density, and numbers of rearing juveniles, immigrating smolts, and/or mature siblings returning in previous years. Data such as temperature and growth are also often used to improve accuracy and precision of the estimates. When age-specific run reconstruction data are available for a stock, forecasting based on numbers of spawners and/or sibling returns can be developed and evaluated inexpensively.

Article V - Enhancement

Abstract

Article V directs the Parties to exchange information pertaining to:

(a) operations of and plans for existing enhancement projects;
(b) plans for new projects; and
(c) each Party's views concerning the other Party's salmon enhancement projects.

Commentary

Based on this wording and bilateral discussions, enhancement reporting obligations will probably require only that available information on current and planned operations be synthesized. There are two Understandings regarding enhancement for the transboundary rivers; both are reviewed later.

Article VII - Transboundary Rivers

Abstract

Article VII provides that if either national section of the appropriate Panel requests, the other section shall provide its views regarding the spawning escapement desired for all stocks that originate in the river.

Commentary

While the type of information specified is not new (see Article IV), a level of detail finer than that of nation of origin suggested.

Article IX - Steelhead

Abstract

In fulfilling their functions, Article IX obligates the Panels and Commission to take into account the conservation of steelhead trout.

Commentary

Very little information exists regarding the status of transboundary river steelhead trout. There are no commercial fisheries that target steelhead trout; therefore, concern for the conservation of these stocks has garnered little attention within the Northern Panel or Commission. However, the obligation to provide basic stock assessment data, if requested, is apparent.

Article X - Research

Abstract

Article X instructs the Parties to conduct research on the stocks of common concern to investigate:

- (a) migratory patterns;
- (b) exploitation patterns;
- (c) productivity;
- (d) status of the stocks; and
- (e) extent of interceptions.

Commentary

Rather than specifying new needs, this Article identifies the kinds of information, in a general sense, needed to implement Treaty Principles.

Annex IV - Fishing Regimes

Overview

Three Chapters of Annex IV apply to stocks of the transboundary rivers: Chapter 1 specifically addresses issues for all salmon species in the transboundary rivers; Chapter 3 addresses transboundary river chinook salmon in the context of coastwide issues; and Chapter 5 addresses transboundary river coho salmon, also in a coastwide context.

Abstract

In Chapter 1 additional direction is provided primarily in the context of management and enhancement. Specifically, the Commission instructs the TTC and the Parties to:

- (a) develop information on migration, exploitation and spawning escapement requirements of pertinent stocks;
- (b) examine management regimes and recommend how they may be better suited to achieving escapement goals;
- (c) identify enhancement opportunities that would:

(i) increase benefits to fishermen with a view to permitting additional salmon to return to Canadian waters and
(ii) have an impact on natural transboundary river salmon production;

(d) improve procedures of coordinated or cooperative management; and
(e) develop the ability to manage Taku and Stikine River sockeye salmon based on in-season assessments of the TAC so as to achieve specified harvest sharing and conservation arrangements among the Parties.

In Chapter 3, the need to account for the annual catch of chinook salmon to achieve Commission goals of rebuilding the stocks is extended to include accounting for unreported associated fishing mortality. The Parties are required to monitor, assess and report associated fishing mortality on an on-going basis to the Chinook Technical Committee. The Committee is subsequently instructed to evaluate those impacts on the coastwide rebuilding program and recommend management actions which account for associated mortality to assure successful completion of the rebuilding program.

In Chapter 5, the need to monitor coastwide escapements of coho salmon stocks is identified. No information or program needs for transboundary river coho salmon stocks are specified.

Commentary

Information needs in these Chapters are generally specified as instructions to the respective technical committees that reiterate the Commission's desire to obtain information pertinent to the goals identified in the Articles.

Memorandum of Understanding

Abstract

Two parts of the Memorandum of Understanding have particular relevance to the transboundary rivers. The first concerns data sharing and the second, deeming of ownership. In regards to data sharing, the Parties agreed to:

(a) develop a stock assessment and management data system capable of providing reliable information in a timely fashion;
(b) develop improved and standardized analytical models to forecast run strength, to analyze tag recovery data, to estimate escapement and to estimate productivity;
(c) improve monitoring and evaluation of annual escapement;
(d) develop and maintain coded-microwire-tag programs;
(e) develop methods in addition to coded-microwire-tagging for identifying and estimating the proportion of various stocks in mixed stock fishery catches;
(f) explore the feasibility of in-season management; and
(g) review methodologies and procedures used to evaluate performance and maintain state-of-the-art techniques.

In the section on transboundary rivers, the Memorandum of Understanding identifies the need to determine the percentage of the annual TAC which shall be deemed of U.S. origin. Although this section states that the Commission shall determine this percentage during the first year of the Treaty, this has not been done yet. The issue is relevant to the equity principle and the Commission intends to negotiate what fraction of these Canadian origin transboundary fish shall be deemed of United States origin.

Commentary

The portion of the Memorandum of Understanding which concerns data sharing identifies types of information that are already mentioned elsewhere in the Treaty. However, the Understanding does elaborate on programs and research topics that are considered important in order for the Commission to fulfill its responsibility.

Understanding Concerning Joint Enhancement, February 1988

Abstract

In this first Understanding concerning joint enhancement for transboundary river salmon, several new information needs are identified:

(a) Information from feasibility studies for enhancement projects selected by the Northern Panel, including:

- (i) costs and benefits,
- (ii) probability of success,
- (iii) implementation schedules,
- (iv) management strategies for enhanced salmon runs,
- (v) evaluation procedures,
- (vi) pathology and fish culture history for selected sites,
- (vii) carrying capacity for juvenile sockeye salmon in Tuya Lake,
- (viii) quality and quantity of spawning area in selected systems, and
- (ix) availability of brood stock at selected sites.

(b) Progress reports and periodic reviews of implemented enhancement projects.

Understanding Concerning Joint Enhancement, February 1989

Abstract

This second Understanding concerning joint enhancement specifies project selection and operation schedules for 1989 and 1990. It requires a reasonable expectation that a method to identify enhanced sockeye salmon in mixed stock fisheries catches can be developed. Also, an Ad Hoc Transboundary Enhancement Work Group is to be established to examine issues of harvest and cost sharing on the Taku River.

CHAPTER 2
REVIEW OF PREVIOUS PLANNING ACTIVITIES

Planning of research and monitoring programs necessary to implement the Pacific Salmon Treaty for transboundary river salmon has proceeded on three fronts. On one, the responsible management agencies have conducted internal planning. On another, the TTC has assessed its needs on several occasions. In addition, the Research and Statistics Committee contracted through the Commission with an independent consulting group to study the needs of the Pacific Salmon Commission for all areas. This resulted in the Shepard and Alverson (NRC 1986) report.

In this review we examine the work of the TTC in outlining its research needs and summarize the appropriate needs identified in the Shepard and Alverson report.

Transboundary Technical Committee Activities

1983 Report

Research and program planning began within the TTC in 1983 when the Committee served an advisory role to the Treaty negotiators (TTC 1983). At that time planning involved developing a list of activities that should be continued on the Stikine, Taku and Alsek Rivers and prioritizing new projects that should be undertaken within each river. No attempt was made to prioritize the list of activities across rivers. The lists developed were not comprehensive, rather they were intended as a planning aid to guide program managers.

For the Stikine River, emphasis for new programs was placed on developing better information on sockeye salmon harvest patterns in the marine fisheries, on making that data available to managers in-season, and on identifying spawning areas in the lower river. Genetic analysis of chinook salmon was also listed. Developing programs to estimate the distribution and abundance of coho salmon escapements and ways to identify Stikine River coho salmon in marine fisheries were ranked below sockeye salmon programs.

For the Taku River, emphasis was placed on developing estimates of timing, distribution and abundance of coho and chum salmon escapements and on identifying rearing areas.

For the Alsek River, determining the ocean harvest rates and migratory routes for chinook and coho salmon using coded-microwire-tags was considered most important. Obtaining escapement data for sockeye spawning in Village Creek was also identified.

1984 Report

In 1984, the Committee (TTC 1984) adopted a more structured approach to research planning. First they identified information needs in three areas important to management programs under proposed Treaty scenarios. The areas identified were:

- (a) development of escapement goals for each stock;
- (b) development of accurate forecasts of run size; and
- (c) development of management systems capable of delivering escapement goals and negotiated harvest shares.

The Committee also concluded that the ability to reconstruct the annual runs by accounting for the catches and counting the escapement would provide the data needed to accomplish these goals.

With these information goals in mind, the Committee then reviewed the current research and management program for each river and species and rated each project's effectiveness as good, fair or poor. Next, they identified new programs that were necessary to meet management goals. Last, the priority of these programs was rated as either high, medium or low. Following this process, the Committee developed a synopsis for each river and stock and made recommendations.

The following general observations regarding data and program needs and priorities are evident in the 1984 report:

For the Stikine River:

(a) the sockeye run reconstruction program developed was quite good, but more emphasis was needed on developing data at the biological stock level of detail;
(b) continued emphasis in assessing sockeye salmon run strength in-season was needed so that conservation and allocation goals of management could be met;
(c) there was little information on coho salmon runs and the ability to meet management goals was poor; therefore, estimating catch in marine fisheries and escapement was recommended;
(d) there was little information on chinook salmon runs and the ability to meet management goals was only fair; therefore, estimating catch in marine fisheries and escapement was recommended; and
(e) chum and pink salmon runs were so small that program needs were not addressed.

For the Taku River:

(a) the sockeye salmon run reconstruction program was well developed, but more emphasis was needed on developing data at the biological stock level of detail;
(b) continued emphasis in assessing sockeye salmon run strength in-season was needed so that conservation and allocation goals of management could be met;
(c) the program to reconstruct the coho salmon run was poorly developed and the ability to meet management goals was also poor; therefore, estimating catch in marine fisheries and escapement was recommended;
(d) the chinook salmon run reconstruction program was poorly developed and it was recommended that emphasis be placed on estimating inriver run strength and on making that data available to managers in-season;
(e) the chum salmon run reconstruction program was poorly developed and it was recommended that escapement be estimated in-season and ways to estimate catches in marine fisheries be developed; and
(f) assessing pink salmon run strength in-season was identified as an important program need, but was rated a lower priority than programs for sockeye, chinook and coho salmon.

For the Alsek River:

(a) the sockeye salmon run reconstruction program and management ability were poorly developed and it was recommended that emphasis be placed on estimating the escapement in-season;
(b) the coho salmon run reconstruction program was undeveloped and it was recommended that emphasis should be placed on estimating the total system escapement;
(c) the chinook salmon run reconstruction program was undeveloped and it was recommended that emphasis be placed on determining if significant interceptions of this stock occur outside the terminal area; and
(d) chum and pink salmon runs were considered too small to warrant much research or planning attention.

1985 Report

In its report for the 1985 season the TTC (1986) continued to use the approach developed in the 1984 report. The majority of the information presented was a restatement of previous years findings. Newly identified needs and recommendations included:

For the Stikine River:

Concurrent analysis of scale, parasite, age and genetic data was recommended in order to improve sockeye salmon stock identification capability.

For the Taku River:

A need to develop management systems for individual sockeye salmon stocks was identified.

For the Alsek River:

(a) determining the feasibility of identifying sockeye salmon stocks that may be harvested in the marine fisheries of Yakutat was rated a medium priority;
(b) determining the extent to which coho salmon are harvested in the Alaska troll fishery was recommended; and
(c) methods to determine total escapement for each species are needed.

1986 Report

In its 1986 report the TTC (1987) emphasized that the highest priority for new programs on the transboundary rivers should be placed on improving those projects which provide managers with in-season assessments of run strength. In addition, the Committee listed seven additional projects that should be considered for implementation. By in large, this list reflected past statements of need. The only significant departure from previous lists was to conduct habitat inventories for the Taku and Stikine Rivers so that information would exist to defend any future recommendations that may be necessary to protect habitat from industrial development.

Shepard and Alverson Report

In 1986 the Pacific Salmon Commission contracted a study to develop technical information requirements for effective implementation of the Pacific Salmon Treaty (Shepard and Alverson (NRC 1986)). To meet basic objectives of the Treaty, the consultants identified four broad purposes for which information was needed. Arranged in the temporal order the information is needed, they are:

(a) forecasting and preseason preparation of fishing and enhancement plans;
(b) in-season control of fisheries;
(c) postseason measurement of performance; and
(d) determination of harvesting and enhancement targets to achieve objectives of the Treaty.

Following discussions with agency technical staff, Panel members, and others involved in implementing the Treaty, the consultants drew several conclusions about research planning within the Commission. Three pertinent conclusions are given here.

(a) Research activities under the Commission are focused in technical committees.
(b) There is no outline of research issues that are being addressed and no comprehensive cross-species, cross-area, cross-committee review of the adequacy of present research efforts.
(c) The Commission has not established specific long-term objectives for its activities and most effort within the Commission has been left to the ad hoc job of implementing annual fishing regimes and to preparations for negotiating new short-term arrangements.

These findings led the authors to conclude that it was premature to develop a specific long-term research plan. Rather, they recommended the Commission undertake a two-pronged approach to develop a long-term plan. The first step they recommended was to review available information on the distribution of stocks among fishing areas, the extent of removals and the abundance of escapements. The second step was to develop a list of options for future long-term management and development programs and to assess implications of such programs with respect to the Treaty. Using this approach, Shepard and Alverson believed that long-term research questions could be identified and planning initiated.

In addition to recommending that the Commission undertake this thorough review and planning process, Shepard and Alverson did make some specific recommendations:

(a) develop computerized data exchange systems;
(b) review existing stock identification technology with the aim of examining and reviewing methodology and fishery sampling requirements, identifying opportunities to cooperate in development and standardization of the methodology, and identifying information priority needs;
(c) obtain better knowledge on the productive potential of stocks;
(d) develop improved techniques for estimating annual escapements, including evaluating the utility of the index system approach; and
(e) initiate a system to assess performance of enhancement activities and strategies.

CHAPTER 3
A FRAMEWORK OF INFORMATION NEEDS FOR THE TRANSBOUNDARY RIVERS

From our review of Treaty documents in Chapter 1 and review of previous planning documents in Chapter 2, we now develop a framework for assessing information and program needs. The four basic elements we have identified are: run reconstruction, fisheries management, information management, and enhancement. The basic components of each element are described below.

Run Reconstruction

Annual run reconstruction provides the basic stock assessment data needed to implement the Pacific Salmon Treaty for the transboundary rivers. The data set is composed of the annual catch in each fishery and the annual escapement. This data set permits estimation of MSY, forecasting, and equity accounting. When conducted on an in-season basis, these same data permit managers to regulate the fisheries so that conservation and allocation goals of management can be met.

Catch Accounting

Perhaps the easiest task is monitoring catches in fisheries by area and through time. However, most stocks of the transboundary rivers are harvested in mixed stock fisheries, thus some method of stock identification is typically required. In addition, the size of the fishing area in relation to the migratory pathways of the stocks also requires geographic stratification of catch, effort and stock composition estimates within single catch reporting areas. Last, knowledge of the migratory pathways is required so that decisions can be made regarding which fisheries to monitor.

Escapement Estimation

Knowledge of levels of escapement provide the basic measure of success of management for conservation of the stocks. Estimates of spawning escapement may be made for the entire river system or for individual stocks.

Escapement Goals

Run reconstruction data, if collected with age information, provides the data needed to set an escapement goal using spawner-recruit analysis. Additional information may also be useful to better understand what freshwater and marine conditions control survival. However, since management programs can only regulate the catch to achieve a desired number of adult spawners, the escapement goal must be specified in these terms.

Preseason Forecasting

Forecasts of the annual run can be made using these same run reconstruction data. Improvement of forecasts may be possible by incorporating ancillary information however, run reconstruction data should be considered first.

Fisheries Management

Fisheries that harvest transboundary river salmon are managed to achieve conservation of stocks and allocation of catch among users. This requires that: 1) run reconstruction programs provide timely estimates of abundance in-season, 2) accurate methods of forecasting the total run size based on in-season estimates of the run-to-date are available, and 3) relationships between fishing power and catch are known and effort can be regulated to achieve the desired catch.

In-season Run Reconstruction

In-season run reconstruction is the primary tool used for fisheries management. The data components of in-season run reconstruction include:

(a) Catch-to-date. Accurate estimates of catch-to-date (by time, area and stock) must be made available to managers in time for use in setting subsequent fishing regulations. For the transboundary rivers, this information must be made available prior to determining the next week's opening.

(b) Escapement-to-date. Escapement estimates (by stock) should be made at least weekly to permit managers time to implement the appropriate response.

(c) Residual Escapement. Residual escapement includes those fish not caught in the fishery but remaining in the area or in between the fishing area and escapement counting site.

Summing these three components at a given point in time would give the size of the run-to-date. Information on migratory timing is also needed to determine what percentage of the run or escapement is through at that point in time.

Another approach often taken is to predict run size from catch-to-date. In this case the fishery is managed by restricting catches to achieve a given escapement, so direct in-season measures of escapement are not needed. Alternatively, total escapement-to-date (residual plus actual) may be estimated by subtracting catch-to-date from the portion of the total run thought to have passed the fishery at that point in time.

In-season TAC Forecasting

In-season forecasting of TAC could be accomplished by either updating forecasts of the total season's TAC based on run strength or determining the weekly TAC for a fishery based on the seasonal TAC, catch-to-date, and migratory timing of the run.

Fishing Power Analysis

Decisions regarding the amount of fishing time in various areas that is required to achieve the desired harvest are based on the fleet's aggregate fishing power. The basic component in this analysis is a unit of effort. Rapid technological development in the fishing industry has made calibration of effort an important part of developing these models.

Information Management

Management of transboundary river salmon to achieve agreed conservation and harvest sharing objectives requires that each Party have timely in-season access to the same data and analytical models used to manage the fisheries. While the Data Sharing Committee has made a start on sharing and updating coded-wire-tag data information, needs of the TTC are broader and include all run reconstruction, forecasting and escapement goal evaluation data. The three basic elements of information management are:

Joint or Shared Data Bases

Each Party assumes responsibility for data that it produces which is used to manage the fisheries and monitor the stocks of common concern. Development of, maintenance of, and access to these data bases are essential for the management agencies and the TTC to fulfill their obligations.

Joint Assessment

Joint management of transboundary river salmon requires that common analytical models be developed and maintained.

On-line Access

On-line electronic access to the joint or shared data bases and to the joint analytical assessment models are needed to improve in-season fisheries management.

Enhancement

Enhancement obligations are of three basic types. The first is to document plans and operations for existing facilities. The second is to develop feasibility studies for the Northern Panel and Commission. The third is to monitor the production from projects that are implemented.

Existing Facilities Documentation

Contents of the annual report of the Parties will be determined at a later date. Based on discussion to date, no new information will be required beyond that routinely made available through each Party's salmon enhancement programs.

Feasibility Studies

The contents of feasibility reports is specified in the first Understanding concerning joint salmon enhancement.

Monitor Production from Joint Projects

Expectations for monitoring of joint salmon enhancement projects is also specified in the first Understanding concerning joint salmon enhancement.

CHAPTER 4
PROGRAM SYNOPSIS

In this chapter we review the status of knowledge of run reconstruction programs, fisheries management, information management, and enhancement activities for salmon of the Stikine, Taku, and Alsek Rivers (Figure 1). Throughout this review, gaps in information and program knowledge are identified. For each river we provide a single table which summarizes the status of knowledge and programs for that river.

Stikine River

The Stikine River (Figures 2 and 3) originates in northern British Columbia and flows to the sea about 32 km south of Petersburg, Alaska. Principal tributaries include the Tahltan, Tuya, Chutine, Skud, and Iskut Rivers. Approximately 90% of the river system is inaccessible to anadromous fish due to natural barriers and velocity blocks. The lower river and most tributaries (e.g. Chutine, Skud, and Iskut) are glacially occluded while the Tahltan and Tuya are clear water lakes. At its terminus, the Stikine is a large, glacially occluded river with a drainage which encompasses about 52,000 km^2.

Alaska harvests Stikine River salmon stocks in mixed stock marine fisheries near the river mouth while Canada operates both commercial and food fisheries on the river. The U.S. and Canada have been cooperating and exchanging fishing and research information from this river since 1982. Status of the knowledge of Stikine salmon stocks is summarized below and in Table 1.

Catch Accounting

<u>Sockeye</u>. Stikine River sockeye salmon comprise a minor fraction of the sockeye harvest in Alaska's Sumner and Clarence Strait (District 106) drift gill net fisheries and a major fraction of the sockeye harvest in Alaska's District 108 drift gill net fishery (Figure 4) as shown by scale pattern analysis (Jensen and Frank 1988). Stocks from the archipelago and mainland of southern Southeast Alaska comprise the majority of the sockeye harvest in District 106 but Canadian Nass and Skeena River stocks make significant contributions in some years. Few, if any, Stikine River sockeye salmon are caught in other Alaskan fisheries such as the District 104 seine fishery, as indicated by scale patterns analysis (Jensen unpublished data), tagging studies (Hoffman et al. 1984), and genetic studies (Wood unpublished data). The annual Canadian catch of Stikine River sockeye salmon is generally greater than the Alaskan marine catch of this run (Figure 4).

Sockeye salmon from Districts 106 and 108 can be identified as originating from two major stock groups within the Stikine River, two major Alaskan stock groups, and one Canadian (Nass and Skeena Rivers) stock group. The stock groups used from the Stikine River are the Tahltan Lake group and the non-Tahltan Stikine group which is a conglomerate of all other Stikine River stocks. The non-Tahltan group includes mainstem spawners (from small lakes, sloughs, and side channels of the mainstem river) and tributary spawners (fish from major tributaries such as the Iskut, Skud, and Chutine River drainages). Separation of inriver sockeye salmon catches into Tahltan and non-Tahltan stocks is possible using either scale patterns (Jensen and Frank 1988) or egg diameters (Craig 1985). A three-way separation of the inriver sockeye salmon run into Tahltan, glacial lakes, and other non-Tahltan stocks is possible based on simultaneous analysis of differences in genotype frequencies, prevalence of the brain parasite *Myxobolus neurobius* and age composition (Wood 1987). Research to determine the feasibility of using genetic, parasite, and scale data concurrently to better differentiate Stikine River sockeye salmon stocks is in progress by the Transboundary and Northern Boundary Technical Committees (TTC and NBTC 1987, Wood 1987, Moles et al. *In press*, Pella and Masuda in prep).

Estimates of stock compositions from the District 106 and 108 and inriver fisheries are provided to managers in-season. Stock composition estimates are refined postseasonally with updated baseline data from the current year's escapement samples. Scale pattern analysis estimates of the proportion of Stikine River sockeye salmon in the District 106 and 108 drift gill net fishery catches, by age class, are available since 1982.

Chinook. Stikine River chinook salmon apparently migrate far to the north and west of Southeast Alaska. Coded-microwire-tag studies were conducted from 1978 to 1981 during which time approximately 101,500 juvenile and 1,300 smolting chinook salmon were tagged (Hubartt and Kissner 1987). Most tagging occurred in the mainstem Stikine River, near the confluence of the Porcupine River. Thirty-four tags have been recovered, mostly from troll fisheries operating to the north of the river in the late spring and early summer. One tag was recovered from Bering Sea trawl catches. Upper river stocks of Stikine River chinook salmon apparently rear outside of Southeast Alaska and are susceptible to harvest only during their maturation migration. Lower river stocks apparently rear in inside waters as indicated from recovered coded-microwire-tags originating from hatchery releases from Andrew Creek broodstocks.

Stikine River chinook salmon are harvested in Alaskan commercial troll, gill net, and seine fisheries although the seine catch is probably insignificant. A recreational fishery near the communities of Petersburg and Wrangell also harvests some Stikine River chinook salmon. There currently is no monitoring of chinook salmon by stock on these fisheries. The available data indicates that Stikine River chinook salmon comprise only a small portion of the mixed stock catches in the District 106 gill net and seine fisheries. Region-wide spring troll fishery closures, instituted in 1981, and delayed openings and area closures in the District 108 gill net fishery, begun in the 1970's, appear to be successful in minimizing catches of upper river stocks so that rebuilding can proceed. If catch restrictions are relaxed following rebuilding, monitoring of catches by stock will be desirable. Chinook salmon are also harvested in the Canadian inriver fisheries (Figure 5).

Coho. Stikine River coho salmon are extensively harvested in Alaskan commercial troll, gill net, and seine fisheries, as demonstrated by recoveries of coded-microwire-tagged fish (Shaul et al. 1984). The troll fishery accounts for the greatest proportion of the Alaskan harvest. Based on coded-microwire-tag estimates for other nearby natural and enhanced production systems, the Alaska troll fishery probably harvests an average of between 35% and 50% of the total coho salmon run to the Stikine River. A recreational fishery near the communities of Petersburg and Wrangell harvests some Stikine River coho salmon. Coho salmon are also harvested in the Canadian inriver fisheries (Figure 5).

Chum. Stikine River chum salmon are harvested in the gill net fishery in the Frederick Sound portion of District 108. These are summer run fish that are taken incidentally when the sockeye salmon fishery is open. Stikine River chum salmon are also taken in limited fishery openings directed at chum salmon, however, these harvests typically total less than 5000 fish annually. A small number of Stikine River chum salmon may also be harvested in the District 106 gill net fishery and in the Canadian inriver fisheries (Figure 5). Seine, troll, and sport fishery catches of Stikine River chum salmon are believed to be insignificant.

Pink. Stikine River production of pink salmon is small and sporadic. It is not believed that there are substantial numbers of Stikine River pink salmon harvested in either the District 106 or District 108 gill net fisheries nor in seine, troll, or sport fisheries. Small catches of pink salmon are taken in the Canadian inriver fisheries (Figure 5).

Steelhead. No information is available on production of Stikine River steelhead trout. Catches of this species in Alaskan fisheries are considered insignificant. Catches of this species are recorded in the inriver Canadian fisheries.

Escapement Estimation and Goals

Estimates of spawning stock sizes needed to achieve MSY based on spawner-recruit relationships are not available for any salmon stocks of the Stikine River. However, stock assessment programs in place for sockeye salmon will permit spawner-recruit analysis for this species in the future. The TTC (1987, 1988b) has established interim management escapement goals for the Canadian portion of the Stikine River based on judgements of the quantity and quality of available spawning and rearing habitat, observed patterns in the distribution and abundance of spawners, and historical patterns of the near terminal area gill net harvest. The interim goals for sockeye salmon are 30,000 to the Tahltan and 30,000 to all other stocks in the river. Escapement goals for the other species are expressed as a range of values (the lower value represents the U.S. goal and the upper value, the Canadian goal) and are as follows: chinook salmon 19,800 to 25,000; coho salmon 38,000 to 50,000; chum salmon 3,000 to 10,000; and pink salmon 5,000 to 6,500. No escapement goal has been made for steelhead trout.

Sockeye. Almost all of the sockeye salmon spawning in the Stikine River takes place in Canada. A weir at the outlet of Tahltan Lake has been used to enumerate the sockeye salmon escapement since 1959. The non-Tahltan Stikine sockeye salmon escapement is estimated from data accrued from a test fishery conducted near the international border (Figure 2). Test fishery catches are apportioned into Tahltan and non-Tahltan fish. Migratory time-density functions are computed for each stock group. Since we can directly estimate the inriver run size (inriver catch plus escapement) of the Tahltan stock, we can indirectly estimate the inriver run size of the non-Tahltan stock by first estimating the relative stock composition of the two stocks in the run (Jensen and Frank 1988; Jensen et al. 1989). Limited aerial and foot spawning ground survey data are available for some non-Tahltan Stikine sockeye stocks (TTC 1988c, TTC 1988d). Developmental work on improving stock identification within the Stikine River using scale, genetic, and parasite characters (Wood 1987) may allow for more stock-specific estimations of escapement in the future.

Estimates of lake rearing capacity for juvenile sockeye salmon have been made for Tuya, Tahltan, Chutine, and Christina Lakes (TTC 1988a) as part of an enhancement evaluation, but no comprehensive study of quantity and quality of spawning habitat is available for these systems.

Chinook. The majority of the chinook salmon spawning areas in the Stikine River are located in Canada. Surveys to estimate the number of chinook salmon spawning in portions of the Stikine River are available since 1956 for Andrew Creek, since 1975 for the Tahltan and Little Tahltan Rivers, and since 1980 for Beatty Creek (Figure 6). In addition, a chinook salmon enumeration weir has been operated on the Little Tahltan River since 1985. Estimates of the total number of chinook salmon spawning in the Stikine River drainage have been made by expanding peak aerial survey counts from the Little Tahltan River. Canada multiplies the index count by 2.13 and the U.S. by 1.60 to expand to the entire Little Tahltan River; a comparison of weir counts and aerial survey counts indicates an expansion of approximately 2.0. Both countries multiply the expanded Little Tahltan estimate by four to estimate chinook salmon escapement to the entire Stikine River drainage (CDFO and ADF&G 1987). The accuracy of this last expansion factor is not known.

Coho. The majority of the Stikine River coho salmon probably spawn in Canada during most years. Data from limited and sporadic aerial surveys of spawning grounds are available for coho salmon in some portions of the Stikine River. A test fishery is operated immediately above the U.S./Canada border throughout the coho salmon migration; however, no data are available to calibrate catch-per-unit-effort (CPUE) to actual escapements. An estimate of above border coho salmon escapements is made based on assuming the same relationship between CPUE and run size as is found for sockeye salmon (TTC 1988c); however, there is no existing method of assessing the reliability of the estimate.

Chum. Very few Stikine River chum salmon spawn in Canada. The major chum salmon runs are located on the north arm of the Stikine River near the river mouth. Several systems are used as spawning indices and are surveyed annually; of these systems North Arm Creek is the major producer.

Pink. Very few Stikine River pink salmon spawn in Canada. Most of the pink salmon production occurs in the lower river; Andrew Creek and North Arm Creek are the major spawning areas. Several systems are monitored annually as indices of run strength.

Steelhead. No monitoring of steelhead trout escapement is done.

Preseason Forecasting

Forecasts of Stikine River runs of sockeye, chinook, and coho salmon are made each year by both Parties. Statistically bounded estimates are not provided. Rather, these forecasts are couched in terms of below, at, or above average returns. No forecasts of chum and pink salmon runs or steelhead trout runs are currently being made.

Programs are in place to provide the data needed to reconstruct the annual run of sockeye salmon. This provides data that also may be used to forecast the runs. In 1988 a time series analysis was combined with a smolt-returning adult model to forecast the Stikine River sockeye salmon run. Forecasting based on sibling run strength has been developed. For chinook salmon, the relationship between the escapement from a brood year at age 4 in a year and the escapement at age 5 in the following year is being developed. Accurate information on the maturity schedules of chinook and coho salmon are available but stock specific production data are lacking. While aerial surveys provide indices of chinook salmon spawning stock size, only inferential data exists for abundance of coho salmon spawning stocks. For these reasons, forecasts of Stikine River coho salmon stocks must be used cautiously.

Fisheries Management

Sockeye. **Catch-to-date** for Stikine River sockeye salmon is provided to managers each week. Estimates are based on on-the-grounds monitoring of catches and in-season stock composition analyses; scale pattern analysis is used on Districts 106 and 108 samples and both scale patterns analysis and egg-diameter analysis, on in-river samples. **Escapement-to-date** is estimated each week from data from the inriver test fishery and from the Tahltan weir. However, because these estimates are significantly delayed with respect to the timing of occurrence of individual stocks in the District 106 and 108 fisheries, these in-season estimates are of limited value to fisheries management there. **Residual escapement** is not estimated.

In-season run reconstruction for Stikine River sockeye salmon is done with a jointly developed Stikine management model (TTC 1988b), which produces weekly updates of run strength based on CPUE from the various pertinent fisheries. The model then determines the annual TAC for each Party based on the run strength estimate, the escapement goal, and Treaty harvest sharing stipulations, and calculates weekly TAC for each Party based on **catch-to-date** and historical migratory timing data in each fishery. **Escapement-to-date** and **residual escapement** are not used in the model. Weekly **forecasts of TAC** are made using the Stikine management model; they are imprecise early in the season but improve after only a few weeks.

The Stikine management model also determines the amount of weekly fishing effort needed to catch the weekly TAC. This assumes constant fishing power within each fishery during the historical period incorporated in the model (1982 to present). Specific **fishing power** models have not been developed. Development has been complicated by changes in the materials and construction of gill nets in Alaska. These changes make comparison of current year CPUE statistics with historical information difficult. Similarly, changes from set to drift gill netting in Canada complicate comparison of recent year and historical CPUE data. In Alaska, gill net mesh efficiency studies are being conducted to examine relationships between fishing power of different types of gear.

Differences in the time-of-entry of the two Stikine stocks in Districts 106 and 108 and in the river exist as shown by analysis of scale patterns (Jensen and Frank 1988, Jensen et al. 1989) and in the river by egg diameter analysis (Craig 1985). These analyses have shown that sockeye salmon bound for Tahltan Lake enter the Stikine River earlier than those bound for other spawning areas and therefore, the two groups can be managed somewhat independently. These differences in migratory timing are an important component of managing the District 108 fishery and the inriver fishery. However, timing differences are of minimal use in managing the District 106 fishery due to the small fraction of the catch contributed by Stikine River stocks (generally less than 5% of the weekly sockeye salmon catch in Sumner Strait and even less in Clarence Strait).

Chinook. Restrictive measures that are in place for the troll fishery and the District 108 gill net fishery appear to be succeeding in rebuilding Stikine River chinook salmon stocks. Once rebuilt and depending upon which restrictive measures are relaxed to permit harvest, an active management program including **in-season run reconstruction, forecasts of TAC,** and **fishing power** will be needed to assure that conservation and allocation objectives of management are realized.

Coho. Stikine River coho salmon present a very difficult management problem. Most are taken in the troll fishery and are mixed with (and not identified from) other stocks; further, these catches are distant in both time and space from the river mouth. Thus, no estimates of **catch-to-date** are made for the troll fishery. Once the run enters the inside waters of S.E. Alaska, a limited assessment of run strength can be made from analysis of CPUE data in the District 108 gill net fishery (when open); however, this is also a mixed stock fishery with stock proportions unknown. No estimates of **catch-to-date, escapement-to-date,** or **residual escapement** of Stikine River stocks outside the river are made. Neither **TAC** or **fishing power models** have been developed for Stikine River coho salmon. Regulation of the District 108 fishery is based on the abundance indices of the mixed stock coho salmon fishery in District 106 and the catches in the region-wide troll fishery.

Chum and Pink. Stikine River chum and pink salmon runs are usually only managed indirectly through management strategies for sockeye and coho salmon. If chum or pink salmon CPUE is high in District 108, limited directed fisheries may occur on either of these species. No methods exist to permit identification of Stikine River stocks of these species in Alaska's District 106 and 108 fisheries. Catches of chum and pink salmon in the inriver fisheries are numerically small and are taken incidently to the catches of other salmon species. While the pattern of observed catches and limited escapement data does suggest that basic conservation objectives are being realized, we have no programs to directly estimate **catch-** or **escapement-to-date**. Likewise, models to estimate **TAC** or **fishing power** have not been developed.

Information Management

Annual and other periodic reports of the TTC and periodic publication of agency technical reports are the primary vehicles for distributing and maintaining data. Through the auspices of the Data Sharing Committee, a process has been established to exchange machine readable copies of coded-microwire-tag and tag-recovery data. However, no programs have been established to develop and maintain **on-line access to joint or shared data bases.** Likewise, there is no **on-line access to joint stock assessment models.**

Enhancement

A central incubation facility exists at Port Snettisham that will be used for joint transboundary river salmon enhancement projects. Existing facilities documentation has been done by the

Transboundary Enhancement Subcommittee (in prep.). **Feasibility studies** for sockeye salmon projects selected by the Northern Panel are continuing.

Joint U.S./Canada sockeye salmon enhancement for Tuya and Tahltan Lakes (Figure 3) will be initiated in 1989; up to three million eggs will be taken from Tahltan Lake. The eggs will be incubated at the Port Snettisham hatchery. The resulting fry will be planted into Tahltan and Tuya Lakes with the distribution to each system based on the strength of the brood year adult sockeye salmon escapement through Tahltan weir. Thermal marking of the enhanced fish, produced by manipulating water temperatures during incubation to produce distinctive otolith banding, is being investigated (Transboundary Enhancement Subcommittee in prep.). Methods for monitoring production are under development.

The U.S. is developing plans to enhance sockeye salmon runs on its side of the border. Alaska Department of Fish and Game (ADF&G) has scheduled a 2 million fish fry plant for Virginia Lake (Figure 3)(near Wrangell, Alaska) in spring, 1989. This lake has previously produced only very small sockeye salmon runs due to a barrier on the outlet. A fish pass was built in 1988 to allow passage of returning adults. The anticipated return from the fry plant is estimated at 42,000 mature sockeye salmon. Fish from the Virginia Lake fry plant would potentially be harvested in Districts 106 and 108 and in a small terminal area during a special opening.

Taku River

The Taku River (Figures 7 and 8) arises in northern British Columbia, Canada, and flows to the sea about 48 km east of Juneau, Alaska. Principal tributaries include the Sloko, Nakina, Inklin, Nahlin, and Sheslay Rivers. The lower river and some tributaries (e.g. Inklin and Sheslay) are glacially occluded while some of the tributaries (e.g. Nakina and Nahlin) are clear water streams. At its terminus, the Taku is a glacially occluded river. The Taku drainage encompasses about 16,000 km^2. Discharge from the Taku River reaches a maximum in summer with a range in the maximum value over years of 787 to 2,489 m^3/s.

Alaska harvests Taku River salmon stocks in mixed stock marine fisheries near the river mouth while Canada operates commercial, food, and sport fisheries in the river. Cooperative research projects have been ongoing on the Taku River since 1983 to assess run and escapement strengths of various salmon stocks.. Status of the knowledge of Taku River salmon stocks in summarized below and in Table 2.

Catch Accounting

Sockeye. Taku River sockeye salmon comprise the major fraction of the sockeye salmon harvest in Alaska's District 111 gill net fishery (Figure 9) as shown by scale pattern analysis (McGregor and Walls 1987) and incidence of the brain parasite, *Myxobolus neurobius* (Moles et al. *In press*). Sockeye salmon stocks from Port Snettisham are the other major component of the catch. The purse seine fisheries in eastern Icy Strait and upper Chatham Strait (Figure 8) target on pink salmon, but also catch some sockeye salmon (Figure 9). These sockeye salmon are not identified to stock, but some are probably from the Taku River as indicated by age composition and run timing data. The annual catch of Taku River sockeye salmon in the Canadian inriver fishery is less than the District 111 catch (Figure 9).

Sockeye salmon from District 111 drift gill net catches can be identified by scale pattern analysis as coming from specific stocks from within the Taku River system or the Port Snettisham drainages (McGregor and Walls 1987). Four stock groups from the Taku River (Kuthai, Little Trapper, and Tatsamenie Lakes and the mainstem Taku River) and two from Port Snettisham (Crescent and Speel Lakes) are separable with this technique. Estimates of stock composition from the District 111 catches are provided to managers in-season. Stock composition estimates are revised postseasonally using current year escapement data to update classification models. Estimates of the proportion of Taku River sockeye salmon in the District 111 drift gill net fishery catch, by age class, are available since 1983. Stock composition estimates are made postseasonally for the Canadian inriver fishery catch by using scale pattern analysis.

Due to the large number of sockeye salmon stocks present in the purse seine fisheries targeting on pink salmon in eastern Icy Strait and upper Chatham Strait, annual accounting of Taku River fish in these fisheries has not been performed and may not be technically feasible using current available stock identification methodology. Research to determine the feasibility of using genetic, parasite, and scale data concurrently to better differentiate Taku River sockeye salmon stocks in mixed stock fishery catches is in progress (TTC and NBTC 1987).

Chinook. Taku River chinook salmon apparently migrate far to the north and west of Southeast Alaska. Extensive coded-microwire-tag studies were conducted from 1977 to 1983 during which time approximately 162,500 juvenile and 35,800 smolts were tagged (Hubartt and Kissner 1987). Tagging occurred in the lower mainstem, the estuary, Tulsequah, at the junction of the Inklin and Nakina Rivers, and on the Nahlin and Nakina Rivers. The approximately 100 tags recovered in fisheries show that these fish are susceptible to harvest essentially only in the spring and early summer during their maturation migration. Almost all fishery tag recoveries have been made in northern Southeast Alaska in the approaches to and in Icy Strait and in areas near the river mouth. However, two recoveries were made south of northern Southeast Alaska; one in British Columbia and one along the outer coast of Prince of Wales Island.

Since 1976, time and area fishing restrictions have been implemented for Southeast Alaska's northern inside area troll, District 111 gill net, and Juneau area recreational fisheries to protect and rebuild Taku River chinook salmon stocks. Because catches in these fisheries have been low since this time, programs designed to account for annual harvests have not been a high priority. If regulations are relaxed to permit harvesting of surplus production, programs to account for annual harvests will be needed for the gill net, troll, and sport fisheries.

Coho. Fluorescent pigment (Gray et al. 1978) and coded-microwire-tag (Shaul 1987, Elliott et al. in prep., Shaul unpublished data) studies indicate that Taku River coho salmon contribute to Alaskan commercial troll, seine, gill net, and sport fisheries. The U.S. harvest of Taku River coho salmon occurs almost exclusively in northern Southeast Alaska. Results from coded-microwire-tag studies in the late 1970's indicated that 61% of the U.S. harvest of Taku River coho salmon was taken by the commercial troll fishery, while 29% was taken in gill net fisheries (primarily in District 111), and 7% and 3%, respectively, by the Juneau area recreational fishery and purse seine fishery in northern Southeast Alaska (Shaul 1987). Shaul concluded that substantial evidence exists to show that average annual U.S. catches of Taku River coho salmon may be in the order of one hundred thousand fish. Catches of coho salmon made in that portion of the District 111 fishery operating in the river mouth (about 80% of the total district catch) are graphed from 1978 to present in Figure 10; Shaul (1987) believes that most of these coho salmon are of Taku River origin. Canadian inriver catches of coho salmon have been much lower than in District 111 (Figure 10).

To monitor exploitation rates, coded-microwire-tag programs have recently been established for some indicator stocks. In the lower river, Yehring Creek was chosen (Elliott and Kuntz 1988); in the upper river, the feasibility of establishing sites on the Tatsamenie and Nahlin Rivers is being determined (Shaul 1987). Supplemental tagging at various mainstem locations will determine if migratory routes and timing of these indicator stocks represent that of other stocks in the watershed. Tagged adults first returned from these programs in 1988. Preliminary results reveal a much lower share of the harvest was taken by the Alaskan commercial troll fishery than in the late 1970's; this is likely due to severe restrictions imposed on the fishery in 1988 and to the increased harvest rates in the sport and gill net fisheries (Elliott et al. in prep.; Shaul unpublished data). Preliminary U.S. harvest rate estimates for 1988 differed for the various indicator stocks: Nahlin River 47%, Tatsamenie 63%, and Yehring Creek 76%.

Trends in the migratory timing of upper river coho salmon stocks have been revealed by fishery recoveries of coded-microwire-tags and spawning ground recoveries of fish that were spaghetti-tagged at Canyon Island during population estimation studies (McGregor and Clark in prep.). Nahlin River coho salmon are the earliest identified spawning stock in the Taku River drainage;

coho salmon from this system passed the lower river tagging site in 1988 between mid-July and early August. Inriver run timing is later for the Hackett River, Tatsamenie Lake, and Yehring Creek stocks than for the Nahlin River stock.

Chum. Virtually all Taku River chum salmon are fall run fish. Most of the harvest of Taku River chum salmon is thought to occur in the District 111 fishery since this is the only fishery in the area which catches large numbers of fall chum salmon. Since summer catches of chum salmon are probably not Taku River stocks, catches shown in Figure 11 for the District 111 fishery include only those made after statistical week 33 (mid-August). However, the Whiting River, which empties into Port Snettisham, also produces fall run chum salmon so fall catches in District 111 are not all of Taku River origin. We currently have no method of identifying Taku River chum salmon in these catches. Canadian inriver catches of chum salmon are small (Figure 11).

Seine openings in outer Excursion Inlet (Figure 8) which occurred prior to the early 1980's probably caught Taku River chum salmon mixed with those of Excursion and Chilkat Rivers. Restricting seine openings to the inner portions of the inlet appears to have reduced seine catches of Taku River chum salmon stocks (McGregor and Marshall 1982).

Pink. Taku River pink salmon are harvested in the District 111 fishery along with other wild stocks and, in recent years, with pink salmon from large hatchery releases in the Juneau area. Figure 12 shows the gill net catches of all pink salmon in District 111 through statistical week 30 (late July), at which time Taku River pink salmon are believed to have passed through the district and entered the river. At present we have no way to separate the component stocks in District 111 catches. Canadian catches of pink salmon are small.

Based on adult tag-recapture data (Hoffman 1982), Taku River pink salmon are also susceptible to harvest by seine and troll fisheries that operate along their principal migration corridor. That corridor is through Icy Strait, around the north tip of Admiralty Island, down Stephens Passage, and into Taku Inlet. Some fish also migrate around the southern tip of Admiralty Island but none appear to enter via southern Chatham Strait. Catches along these migratory routes are composed of a large number of stocks and we have no way of separating the catches into component stocks.

Steelhead. It is thought that U.S. fisheries harvest insignificant numbers of Taku River steelhead trout. Steelhead trout are caught in small numbers in the Canadian inriver fisheries.

Escapement Estimation and Goals

Estimates of spawning stock sizes needed to achieve maximum sustained yield based on spawner-recruit relationships are not yet available for any of the salmon stocks of the Taku River. However, the TTC (1988b) has established interim management escapement goals based on judgement of the quantity and quality of available spawning and rearing habitat, observed patterns in the distribution and abundance of spawners and historical patterns of the near terminal area gill net harvest. Escapement goals for the various species are expressed as a range of values and are as follows (the lower value for each species represents the U.S. goal while the upper value is the Canadian goal): sockeye salmon 71,000 to 80,000; chinook salmon 25,600 to 30,000; coho salmon 27,500 to 35,000; chum salmon 50,000 to 80,000; pink salmon 150,000 to 250,000. There currently is no escapement goal for steelhead trout. No stock-specific spawner-recruit data are available.

Inriver Adult Mark-Recapture Program. To estimate the total number of fish escaping upstream of the U.S.-Canada border, an adult mark-recapture study was begun in 1981. Initially, the program provided estimates only for sockeye salmon. Efforts to expand the program to cover other salmon species have been recently been undertaken (McGregor and Clark 1988). Tagging is conducted by a crew of Canadian and Alaskan personnel; the incidence of these tagged fish in Canadian catches forms the basis for sockeye salmon estimates. Mark-recapture estimates of the Taku River sockeye salmon escapement since 1984 are shown in Figure 9. Estimates of the inriver sockeye run size are developed each week during the fishing season. However, because of the time it takes for fish to migrate from the District 111 fishery area upriver past the tagging site and through the Canadian fishery, these run size estimates are lagged several weeks behind the District 111 fishery. For the other species, estimates are developed after the fishing season and are based on spawning ground and/or commercial and test fishery recoveries. Current limitations in the program include: the chinook salmon program is still under development; tagging of coho salmon late in the fall has been problematic due to low water conditions; fishery recoveries of tagged coho salmon have been low due to limited commercial and test fishery catches; limited tag recovery effort on chum and pink salmon precludes precise estimates for these species; and little emphasis is placed on even-year pink salmon tagging because the population is small relative to odd-year runs.

Sockeye. Many discrete stocks of sockeye salmon have been identified in the Taku River. Because production between stocks is independent, substantial effort is being directed at estimating reproductive success of individual spawning populations. To delineate the location and utilization of spawning areas, radio transmitters have been affixed to some fish to follow their movements (Eiler et al. 1988). Picket weirs have been installed to count fish as they migrate into three of the important spawning areas (Little Trapper and Little Tatsamenie Lakes and the Hackett River). On the U.S. side of the border, a partial escapement count to Yehring Creek is obtained at a weir. Aerial and foot surveys of several other spawning areas below the border are conducted. Sockeye salmon spawning populations in many of the important spawning areas are sampled for age, sex, and length composition (McPherson et al. 1988).

Estimates of numbers of returning adults from known escapements are being made for the entire system and separately for Little Trapper and Tatsamenie Lake stocks. Estimates of lake rearing capacity for juvenile sockeye salmon have been made for Tatsamenie, Kuthai, Little Trapper, Trapper and King Salmon Lakes (TTC 1988a) as part of an enhancement evaluation study, but no comprehensive study of quantity and quality of spawning habitat is available for these systems. Patterns of juvenile sockeye salmon utilization of the lower river (Murphy et al. in prep) have revealed that the lower river is an important rearing and overwintering habitat. Coupled with estimates of total rearing area, this information may be useful in determining the carrying capacity of the lower river and in establishing escapement goals for mainstem spawning stocks.

Chinook. Surveys to estimate the number of chinook salmon spawning in tributaries of the Taku River began in 1951. By 1965, surveys were routinely conducted on six index tributaries; beginning in 1974 the methodology was standardized between tributaries (Kissner 1975). Estimates of the total number of chinook salmon spawning in the Taku River drainage have been made by expanding peak aerial survey counts on the Nakina and Nahlin Rivers to account for that portion of the population not observed in these tributaries (Canada uses 1.67 and the U.S. uses 1.33 for an expansion factor) and for tributaries not surveyed (both nations use 1.67 for an expansion factor; CDFO and ADF&G 1987). Peak aerial survey counts for the Nakina and Nahlin Rivers and U.S. estimates of annual Taku River escapements are shown in Figure 13. There are no known chinook salmon spawning areas below the U.S.-Canada border.

The adult chinook salmon mark-recapture program was initiated in 1988 to determine the accuracy of these expansion factors. Tagged chinook salmon are recaptured at weirs located on the Nakina, Hackett, Nahlin Rivers and Little Tatsamenie Lake and during carcass surveys at other locations. Marked-to-unmarked ratios of recovered fish will provide a means to obtain an estimate of the entire Taku River chinook salmon escapement. Samples to estimate age, sex and length composition of escapements are also obtained at these sites. Since the sex ratio of the Taku River chinook salmon escapement is variable (CDFO and ADF&G 1987), it is important to estimate this parameter in order to judge the potential production from given escapements. A program is planned for 1989 to assess the feasibility of using radio tags to estimate the fraction of the chinook population spawning in index tributaries and unsurveyed areas.

The feasibility of using historical escapement data from spawning ground and aerial surveys to develop spawner-recruit relationships for individual spawning populations is being explored. This analysis depends on the assumption that harvest rates are low and fairly constant between brood years. It is too soon to judge the success of this approach. However, if the stock is rebuilt, increased harvests resulting from relaxation of time and area fishery restrictions would preclude this type of analysis unless stock identification programs are instituted for the marine fisheries.

Coho. For past years, only sporadic aerial and foot surveys of coho salmon spawning in tributaries of the Taku River are available. Currently, index escapement counts are being provided at weirs at Little Tatsamenie Lake, Hackett River, Nahlin River and Yehring Creek. Above border escapement estimates are being developed using adult mark-recapture techniques and are available for 1987 (Figure 10), but problems exist in capturing fish for tagging and examining fish for tags during the last part of the run.

Run reconstruction data being obtained at Yehring Creek, below the border, and possibly above the border at the Nahlin River and the Tatsamenie Lake system may permit estimation of spawner-recruit relationships for these index systems. Analysis of the distribution and abundance of rearing coho salmon (Murphy et al. in prep.), when coupled with estimates of total available rearing habitat, may also prove useful in establishing escapement goals.

Chum. The feasibility of estimating chum salmon escapements is being determined. Adults are tagged at Canyon Island and recoveries are made in inriver commercial and test fisheries. The principal problem with this escapement estimation procedure has been that only small numbers of chum salmon have been taken in the fisheries, so the precision of the resulting escapement estimate is very low.
Only limited information is available on the location and importance of chum salmon spawning areas within the drainage. Sporadic aerial surveys have noted concentrations of chum salmon spawning in the King Salmon Flats area along the mainstem Taku River, but no other substantial spawning areas have been identified including none below the border. Age, sex, and length composition of chum salmon in the escapement is estimated from fish wheel catches.

Pink. Data from sporadic aerial surveys exists to document escapements of pink salmon in the Taku River (Figure 12). The major pink salmon spawning area is in the Nakina River. Prior to initiating the Canyon Island tagging program these aerial surveys and counts of pink salmon carcasses that drifted onto the Nakina carcass weir were the best sources of escapement data. Recovery of Canyon Island tags both above and below the Nakina weir now provides the data needed to make estimates of the escapement in odd-numbered years when pink salmon runs are relatively large. Because few fish are tagged and recovered in relation to population size, estimates produced have been imprecise. Returns of Taku River pink salmon in even-numbered years since 1984 have been so poor that mark-recapture estimates have not been attempted. Although pink salmon are known to spawn in several areas below the U.S.-Canada border the relatively small size of the spawning population below the border compared with above the border makes estimation programs not worthwhile.

Steelhead. No monitoring of steelhead trout escapements is done.

Preseason Forecast

No statistically valid forecasts of Taku River salmon runs are currently being made. Rather, preseason expectations of run size are couched in terms of below, at, or above average. No forecasts of steelhead trout runs are made.

Programs are in place to provide the data needed to reconstruct the annual run of sockeye salmon; after several years, these data should facilitate better forecasting based on stock-specific parameters. For chinook salmon, the relationship between the escapement from a brood year at age 4 in a year and the escapement at age 5 in the following year is being developed. While this forecast utilizes only abundance and age composition data gathered on the spawning grounds, the apparently low exploitation rate experienced by this species should cause only minor bias in the forecast until catches are allowed to increase. The lack of comprehensive estimation of marine catches for coho, pink, and chum salmon limits forecast development.

Fisheries Management

Sockeye. **Catch-to-date** for Taku sockeye salmon is provided to managers each week. Estimates are based on on-the-grounds monitoring of catches in Alaska's District 111 gill net fishery coupled with scale pattern analysis and monitoring of the Canadian inriver fishery. However, no in-season estimates of catches made in purse seine fisheries are available. **Escapement-to-date** is provided each week from the Canyon Island mark-recapture program. However, the usefulness of these estimates is decreased because the estimates are delayed with respect to the timing of individual stocks through the District 111 fishery. The **residual escapement** is not estimated. **Forecasts of TAC** are made by Canada using in-season escapement estimates, inriver and District 111 catches, and comparison of current year inriver CPUE with historical data; however, these estimates are imprecise. In Alaska, catch-by-stock data are combined with effort statistics and compared with historical patterns to assess run strength but no estimates of TAC are made. As with fisheries management in the Stikine River and associated waters, **fishing power** models have not yet been developed due to changes in fishing gear over time. However, the relatively stable sockeye salmon production observed in recent years has simplified management.

Differences in the migratory timing of Taku River stocks exist as shown by analysis of scale patterns and inriver mark-recovery data (McGregor and Walls 1987; McGregor and Clark 1987). While differences in migratory timing are an important component of managing the District 111 fishery in order to achieve optimal distribution of the escapement, lack of accurate in-season estimates of escapement by stock limits monitoring the success of this approach.

Chinook. Restrictive measures that are in place for the northern troll, District 111 gill net, and Juneau area recreational fishery appear to be slowly succeeding in rebuilding Taku River chinook salmon stocks. If stocks rebuild to levels that can support increased harvests and depending upon which restrictive measures are relaxed to permit harvest, an active management program including the **catch and escapement to date, forecasts of TAC**, and **fishing power** analysis will be needed to assure that conservation and allocation objectives of management are met.

Coho. Taku River coho salmon present a very difficult management problem. Most are taken in the troll fishery when mixed with other stocks and not identified to stock; further, these catches are distant in both space and time from the river mouth. Thus, no estimates of **catch-to-date** are made for the troll fishery. Once the run enters the inside waters of Southeast Alaska, assessment of run strength is made from analysis of CPUE data in the District 111 commercial and Juneau area recreational fisheries, both of which are mixed stock fisheries for which no estimates of **catch-to-date** for Taku River stocks are made. **Escapement-to-date** and **residual escapement** are inferred from catches in the terminal area and in the inriver test fisheries, but no quantitative relationships have been developed. No formalized **TAC** or **fishing power models** have been developed for Taku River coho salmon. Regulation of the near-terminal area gill net fishery is based on comparison of current year CPUE data with historical information.

Chum and Pink. Management of the District 111 gill net fishery for Taku River chum and pink salmon is based solely on analysis of CPUE data. While the pattern of catches observed and the existing escapement data does suggest that basic conservation objectives are being realized, we have no programs to directly estimate **catch-** or **escapement-to-date**. **Catch-to-date** of Taku River chum and pink salmon in the District 111 fishery is approximated by assuming that only late season catches of chum salmon and only early season catches of pink salmon are of Taku River origin. The accuracy of these approximations is unknown due to the presence of other stocks. Models to estimate **TAC** and **fishing power** have not been developed.

Information Management

Annual and periodic reports of the TTC and periodic publication of agency technical reports are the primary vehicles for distributing and maintaining data. A **joint database**, to be printed as an appendix to the TTC annual report, is being developed. **Joint assessment** of run reconstruction is made for Taku River sockeye salmon, but no joint assessment models have been developed for the other species. Through the auspices of the Data Sharing Committee, a process has been established to exchange machine readable copies of coded-microwire-tag and tag-recovery data. There is currently no **on-line access** to either databases or assessment models for Taku River salmon.

Enhancement

Joint sockeye salmon enhancement projects on the Taku River will be initiated in 1990. Up to six million eggs will be taken from Little Trapper Lake and/or Little Tatsamenie Lake. The resulting fry will be planted into larger lakes located in the same drainage but upstream from the egg take sites (Trapper and/or Tatsamenie Lakes). A method of marking the enhanced fish is under development. Thermal marking of otoliths, produced by manipulating water temperatures during incubation to produce distinctive otolith banding patterns, is presently being evaluated by the Transboundary Enhancement Subcommittee (in prep.).

The U.S. is developing plans to enhance sockeye salmon runs on its side of the border as well. Rehabilitation of Port Snettisham sockeye runs (Speel and Crescent Lakes) was begun in 1988 with a small egg take at Speel Lake. Plans are to eventually rebuild these runs to historical levels. Enhancement plans for development of a sockeye salmon run to Turner Lake, located 35 km southeast of Juneau (Figure 7), are underway. This lake presently does not support anadromous salmon runs because several outlet falls form a barrier to migration. Available limnological data suggests the lake is capable of supporting large numbers of rearing juvenile salmon. Project approval is still pending; if current plans are approved, the Turner Lake project will begin with a five million egg take in the fall of 1989 and planting of the resulting fry into Turner Lake in the spring of 1990.

Alsek River

The Alsek River arises in the Yukon Territory, flows through northern British Columbia and empties into the sea about 75 km southeast of Yakutat, Alaska (Figures 14 and 15). The Dezadeash and Tatshenshini Rivers are two main tributaries of the Alsek River. Access to the upper Alsek River, above the confluence of the Tatshenshini River, has been blocked to anadromous fish by glacial activity in the past. The Alsek River is glacially occluded at its terminus and has peak summer discharges greater than either the Stikine or Taku Rivers.

Alaska has commercial fisheries operating in the lower Alsek River and along the nearby coast while Canada operates food and sport fisheries on the river. Relatively little research on salmon stocks is being conducted on the Alsek River in comparison with the Stikine and Taku Rivers. The status of knowledge of Alsek River salmon stocks is summarized below and in Table 3.

Catch Accounting

Sockeye. In Alaska, commercial inriver and near terminal area surf set gill net fisheries target on Alsek River sockeye salmon. The harvest occurs primarily in the lower 23 km of the Alsek River, with small numbers of fish taken in surf areas within three-quarters of a mile in each direction from the river mouth. Catches are shown in Figure 16. Since 1983, the opening of the Alsek fishery has been delayed one to three weeks because of conservation concerns for early run sockeye and chinook salmon stocks. Annual monitoring of the catch by age is conducted in the Alsek River fishery. No estimates of the stock composition of lower river harvests are available.

Unknown numbers of Alsek River sockeye salmon are also taken in Alaskan set gill net fisheries at Manby Shore and Yakutat Bay (Figure 15). The stock compositions of catches in these fisheries are unknown; however, returns of coded-microwire-tagged Situk River sockeye salmon in 1987 indicated that the Situk River contributed over 50% of the Yakutat Bay sockeye salmon harvest (Alexandersdottir 1987). Some Alsek River sockeye salmon may also be taken by the nearby surf fishery of the East Alsek River, but available run timing and age composition data suggest a low level of such interceptions.

Canada does not commercially harvest Alsek River fish; however, sport and native food fisheries occur in the upper Tatshenshini River drainage. The majority of sport fishing effort takes place near the mouth of the Klukshu River, while the food fishery occurs at the outlet of Klukshu Lake upstream from a weir operated by Canadian Department of Fisheries and Oceans (CDFO). More sockeye salmon are taken in the food fishery than in the sport fishery (Figure 16). Canadian harvests of sockeye salmon are lower than Alaskan catches and have been restricted in recent years to protect chinook salmon and early run sockeye salmon.

Chinook. Chinook salmon are harvested in the U.S. Alsek River fishery and the Canadian sport and food fisheries. The delayed season openings of the U.S. fishery have resulted in reduced chinook salmon harvests since 1983 (Figure 17). In Canada, more chinook salmon are typically taken in the sport fishery than in the food fishery (Figure 17). Unlike Stikine and Taku River chinook salmon, Alsek River stocks have not responded positively to conservation measures taken in the 1980's to rebuild runs (CDFO and ADF&G 1987). Reasons for this failure are poorly understood. Migration patterns of Alsek River chinook salmon are unknown. It is not known if Alsek River chinook salmon contribute to the Alaskan troll fishery. A coded-microwire-tag study is currently being conducted to determine the contribution of Alsek River chinook salmon to marine fisheries.

Coho. Alsek River coho salmon are targeted on late in the season in the Alsek inriver and surf fisheries (Figure 18). The contribution of Alsek River coho salmon to Alaskan troll fishery catches is unknown, thus no annual catch accounting is possible at present. Small numbers of coho salmon are taken in the Canadian inriver sport fishery (Figure 18), while the species is generally not harvested in the Canadian food fishery.

Chum and Pink. Small numbers of chum salmon are taken in the U.S. Alsek River fishery. Catches have averaged less than 500 chum salmon annually since 1964. Small numbers of pink salmon are also taken in the U.S. Alsek River fishery. Catches have averaged less than 100 pink salmon annually since 1964. Chum and pink salmon are not taken in the Canadian fisheries.

Steelhead. Alsek River steelhead trout catches are not reported by the TTC; production of steelhead trout in this system is unknown.

Escapement Estimation and Goals

Escapement goals for Alsek River salmon have been developed by the TTC (1987), but are based on professional judgement rather than hard data. Escapement goals for the various species are expressed as a range of values and are as follows (the lower value for each species represents the U.S. goal while the upper value is the Canadian goal): sockeye salmon 33,000 to 58,000; chinook salmon 7,200 to 12,500; coho salmon 5,400 to 25,000; chum and pink salmon 500 each. An interim escapement goal of 20,000 to 30,000 sockeye salmon for Klukshu Lake has also been identified (TTC 1988b).

No total drainage **escapement estimation** programs currently exist for any salmon species in the Alsek River.

Sockeye. A weir has been operated on the Klukshu River annually since 1976 and has provided counts of sockeye salmon migrating into Klukshu Lake. Age, sex, and length data are collected from fish sampled at the weir, so the escapement by age class can be determined. In 1983 an adult sockeye salmon tag and recovery project was conducted. Fish were tagged at a location just above the Alaskan inriver fishery, while recoveries were made from fish passing through the Klukshu weir (McBride and Bernard 1984). This study suggested that 37% of the sockeye salmon escapement to the Alsek River drainage returned to Klukshu, substantially lower than the 60% Klukshu contribution previously assumed based solely on professional judgement (TTC 1987).

Two runs of Klukshu sockeye salmon (early and late) have been identified (TTC 1988c). Sockeye salmon passing through the Klukshu weir by August 15 are designated as the early run and are considered depressed and in need of conservation. Klukshu weir counts of sockeye salmon in the early and late runs are shown in Figure 16. It is not known if the spawning distribution, emergence timing, and potential productivities of the early and late runs differ from each other. Nor is it known whether separate escapement goals for the two runs are necessary or even feasible to manage for.

Estimates of lake carrying capacity are available for Klukshu Lake (TTC 1988a). Available return-per-spawner, limnological, and fry rearing density data for Klukshu Lake suggest that the escapement goal for this system may be higher than that needed for optimal production. Work is being done to develop new escapement goals.

The sockeye salmon escapement into Village Creek has been monitored annually since 1986 using an electronic counting device. Sporadic aerial survey data is available for several sockeye salmon systems on the U.S. side of the border (TTC 1988d).

Chinook. Counts of the chinook salmon escapement into Klukshu Lake have been made annually at the Klukshu weir (Figure 17). Age, sex, and length data are collected from fish sampled at the weir, so the escapement by age class can be determined. Estimates of the total number of chinook salmon spawning in the Alsek River drainage have been made by expanding the Klukshu weir count to account for the tributaries not surveyed. Canada and the U.S. use different expansion factors (Canada uses 2.0 and the U.S. uses 1.56); the accuracy of these factors is unknown and needs to be determined (CDFO and ADF&G 1987).

Other Species. Coho salmon are counted through the Klukshu weir (Figure 18), however icing conditions late in the fall have precluded obtaining complete counts of this run. Aerial survey data are available for several coho salmon systems on the U.S. side of the border, but the data are sporadic in nature.

No attempt is made to estimate escapements of chum and pink salmon due to the small run sizes of these species.

Preseason Forecasting

Forecasts of Canadian Klukshu sockeye and chinook runs are made by applying average return-per-spawner values obtained for stocks of other river systems and observed maturity schedules. Statistically bounded estimates are not provided. Rather, these forecasts are limited to predicting returns of below, at, or above average. Incomplete counts through the Klukshu weir preclude even this crude approach to forecasting coho salmon runs.

Accurate run reconstruction data for the entire Alsek River drainage is not available due to the lack of escapement information. Annual run reconstruction of Klukshu sockeye and chinook salmon can be developed using weir counts, assuming that Klukshu stocks represent a given proportion of the Alsek River harvests. Continued collection of this data should facilitate improved sockeye and chinook salmon forecasting based on stock specific parameters; however, the ultimate accuracy of such forecasts may be limited by the lack of stock identification in the lower Alsek River fishery.

Fisheries Management

Sockeye. **Catch-to-date** of Alsek River sockeye salmon is determined from on-the-grounds monitoring of catches conducted in Alaska's commercial inriver and surf set gill net fisheries. Comparison of current year CPUE with historical data is the basis for fishery regulations. A direct measurement of **escapement-to-date** is not available; however, a sockeye salmon abundance model has been developed that provides in-season predictions of the total Alsek River catch and Klukshu escapement (McBride and Bernard 1984). The model incorporates effort, CPUE, and migratory timing data and has been used for the last five years. Predictions have been accurate and are generated early enough in the season to allow managers to reduce fishing effort if the return appears weak. This has proved valuable since Klukshu weir counts are not available during the fishing season due to the time necessary for fish to migrate from the fishery to the weir. No estimates of **residual escapement** are made. Since harvest sharing agreements are not in place on the Alsek River **forecasts of TAC** are not made. However, fisheries are managed to attempt to obtain escapement goals. **Fishing power** models have not been developed.

Other Species. Monitoring of catches provides **catch-to-date** information. **Escapement-to-date** is not available for any of the species. **Residual escapement** is not estimated and development of **forecasts of TAC** and **fishing power** models have not been done. Comparison of current year CPUE with historical data forms the basis for fishing regulation of chinook and coho salmon. No active management of Alsek chum and pink salmon stocks occurs because of the small magnitude of existing runs.

Information Management

Annual and periodic reports of the TTC and periodic publication of the agency technical reports are the primary vehicles for distributing and maintaining data. Through the auspices of the Data Sharing Committee, a process has been established to exchange machine readable copies of coded-microwire-tag and tag-recovery data. The TTC has identified, in a letter to the Data Sharing Committee, development of a comprehensive electronic data base with **on-line access** as a high priority need, but no work has been undertaken in this area.

Enhancement

There are currently no enhancement projects planned for the Alsek River. Feasibility studies are in progress. The TTC recommended that if enhancement of Klukshu Lake is undertaken, lake enrichment should be the strategy used rather than increasing fry recruitment (TTC 1988a).

CHAPTER 5
EVALUATION OF PROGRAM NEEDS

In this chapter we present our current evaluation of the most critical gaps in information that remain for the transboundary rivers. Information needs were prioritized by ADF&G staff in October of 1988 into "high", "medium" and "low" categories. In addition, we suggest possible programs for obtaining this information and provide projected estimates of the potential costs involved. High and medium prioritized projects are summarized in Table 4.

Stikine River

Identified information needs for the Stikine River were primarily focused on chinook and coho salmon. Improved programs to estimate the escapements and to develop marine catch accounting programs for these two species were given high priority.

Radio tagging of chinook salmon offers promise to determine the spawning distribution of this species in the drainage; such information is critical in both identifying unknown spawning areas and in assessing the accuracy of the tributary expansion factor currently used to generate total Stikine River chinook salmon escapement estimates. Radio tagging is extremely costly, but it would likely need to be performed only several years to yield results. An adult mark-recapture program could be operated to generate coho salmon escapement estimates. Because suitable sites for catching and tagging fish and recovering tags are located upstream from coho salmon producing systems in Alaskan portions of the drainage, resulting escapement estimates would cover only the portion of the run that returns to Canada. It would be necessary to increase test fishery catches, in addition to sampling the commercial fishery, to obtain sufficient tag returns to generate reasonably precise estimates. An adult mark-recapture program would be expensive and would have to be conducted annually.

Accounting for marine catches of Stikine River chinook and coho salmon received a high priority rating. For chinook salmon, marine catch accounting will become important if fishery restrictions implemented to rebuild Stikine River stocks are relaxed. A coded-microwire-tag program on the Little Tahltan system would provide estimates of exploitation rates on this stock. The contribution of the Andrew Creek stock, located in the lower river and demonstrated to have different migratory behavior than upper river stocks, could also be determined by a coded-microwire-tag project. These programs are annual in nature and are relatively expensive. Stock identification methods capable of accurately estimating fishery contributions of Stikine River chinook salmon are highly desireable but none is currently available. Developing a marine catch accounting program for Stikine River coho salmon presents even greater problems. Coded-microwire-tagging may be a promising technique if discrete representative stocks can be identified. Scale pattern (SPA) and electrophoretic (GSI) techniques do not appear to offer much promise for differentiating coho salmon stocks.

Taku River

High priority information needs for the Taku River included improvement of escapement estimates for coho salmon and marine catch accounting for chinook and coho salmon. No programs are currently conducted to estimate marine harvests of Taku River chinook salmon. Coded-microwire-tag studies in prior years indicated that Taku River chinook salmon are available for harvest in marine fisheries in Southeast Alaska only during their spring spawning migrations. Sport and commercial fishery restrictions have been employed to limit the harvest of Taku River chinook salmon. If these restrictions are relaxed, development of marine catch accounting will become important. Several methods, varying in both cost and the scope of information generated, are available to estimate stock contributions. Intensive sampling for maturity index (gonad developmental stage) information, together with existing creel census, commercial catch monitoring, and scale and coded-microwire-tag recovery sampling can provide data on the harvest of hatchery and wild (primarily Taku River) spring spawning chinook salmon in the near-terminal area Alaskan recreational and commercial gill net fisheries. This data is already routinely collected, with the exception of maturity index information, so the cost of implementing this work would be low. A more costly alternative would be to coded-microwire-tag juveniles on the two principal chinook salmon index systems, the Nakina and Nahlin Rivers. This would allow harvest rates for these stocks to be determined for terminal and non-terminal fisheries. This is not warranted at present because of the current lack of fishing effort on these stocks in non-terminal areas. Other stock identification methods have not been applied to these stocks, but could offer long term cost and technical advantages if money was available to develop them.

Improvements to coho salmon escapement estimates can be made by modifying the current adult tagging program, eg. extending the tag program through the end of September and increasing inriver test fishery effort to recover more tags. These changes can be made without a large infusion of money. However, this program does not offer great promise in providing timely in-season escapement estimates because of the lag time in fish migration between U.S. fisheries and inriver tagging and recovery sites.

An intensive coho salmon coded-microwire-tag program on Taku River index systems is currently operated to provide estimates of marine harvests of Taku River coho salmon stocks. Harvest rates and total run sizes of these index stocks are provided by this program. These estimates, combined with other catch and escapement data, will probably make it possible to make approximations of total fishery contributions. Stock identification techniques have not been developed for Taku River coho salmon. Although stock identification would be valuable to improve the estimate of the contribution of Taku River coho salmon to marine fisheries it would likely be expensive.

Development of chum salmon escapement estimates was rated a medium priority. Escapement estimates could be derived at little additional cost in combination with improvement of the coho salmon mark-recapture program.

Alsek River

No projects for the Alsek River were rated as a high priority. Catch accountings of chinook and coho salmon were given a medium priority. Coded-microwire-tagging of lower river stocks and of the upper river Klukshu Lake stocks could provide information on the migratory routes of Alsek River chinook and coho salmon and reveal fisheries in which they are harvested. Exploitation rates could probably be estimated for the Klukshu River stocks, but the representativeness of these stocks of the system as a whole is unknown and would need to be evaluated. Juvenile chinook salmon were coded-microwire-tagged in 1988.

Improving escapement estimates for sockeye, chinook, and coho salmon runs to the Alsek River also were rated as medium priorities. For chinook salmon, a radio tagging program would allow the distribution of this species within the drainage to be determined and would allow the accuracy of the tributary expansion factor currently used to develop total Alsek River chinook salmon escapement estimates to be assessed. This program would be extremely expensive, especially considering the relatively small magnitude of the run. A lower river adult sockeye salmon mark-recapture study could be repeated for comparison with results from a 1983 program to determine the contribution of Klukshu stocks to the total Alsek River sockeye run. Sonar could also be used to estimate the Alsek River sockeye salmon escapement. Either program would be expensive to operate. Developing a coho salmon escapement estimate does not currently appear feasible or practical.

Generic Issues

Several generic issues of importance to all transboundary rivers research were identified. Development of an on-line information system to allow timely access to joint or shared data bases needed to manage fisheries was given a high priority. Providing additional biometric assistance to managers to develop management systems was also identified as an important need. Last, progress on developing an effective mass-marking technique for enhanced sockeye salmon was identified. ADF&G is currently studying thermal marking of otoliths as a mass-mark.

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Table 1. Status of Stikine River salmon research and management programs in 1989. Blanks in the table mean that the information is not necessary under the guidelines of the Pacific Salmon Treaty.

	Species					
Program Element	**Sockeye**	**Chinook**	**Coho**	**Chum**	**Pink**	**Steelhead**
Run Reconstruction						
Catch Accounting						
Canadian Inriver Fisheries						
By stock	A	G[1]	G			
Total	A	A	A	A	A	A
U.S. Gill Net Fishery						
By stock	A	G[1]	H,G			
Total	A	H,G[1]	G	?	?	
U.S. Seine Fishery						
By stock	H		H,G			
Total	H	H	G			
U.S. Troll Fishery						
By stock		G[1]	H,G			
Total		H,G[1]	G			
U.S. Sport Fishery						
By stock		G[1]	H,G			
Total		H,G[1]	G			
Escapement Estimation						
Above Border	A	I,G	A[2],G			G
Below Border		I	I,G	I	I	
Total by Stock	A,D	G	G			
Escapement Goals	D,E	E	E[3]	E[3]	E[2]	
Forecasting	A,D	D	D,I			
Fisheries Management						
In-Season Run Reconstruction						
Catch-to-Date	A	G[1]	G			
Escapement-to-Date	A	G[1]	G			
Residual Escapement		G[1]	G			
TAC Forecasting	A	G[1]	G			
Fishing Power Analysis	D	G[1]	G			
Information Management						
Joint or Shared Data Bases	D	H[3],D	H[3],D	D	D	D
Joint Assessment Models	A	G	G			
On-Line Access	G	G	G			
Enhancement						
Existing Facilities Doc.	A					
Feasibility Studies	A					
Monitoring Production	D					

KEY:
- ? uncertain if information gap exists
- A annual program underway
- D Developmental program to improve estimates
- E estimate exists
- G identified information gap
- H historical index program exists
- I index program in place

NOTES:
1. when restrictions relaxed following rebuilding.
2. reliability unknown.
3. CWT data base only

Table 2. Status of Taku River salmon research and management programs in 1989. Blanks in the table mean that the information is not necessary under the guidelines of the Pacific Salmon Treaty.

	Species					
Program Element	**Sockeye**	**Chinook**	**Coho**	**Chum**	**Pink**	**Steelhead**
Run Reconstruction						
Catch Accounting						
Canadian Inriver Fisheries						
By stock	A	G[1]	G			
Total	A	A	A	A	A	A
U.S. Gill Net Fishery						
By stock	A	H,G[1]	I			
Total	A	H,G[1]	G	T	T	
U.S. Seine Fishery						
By stock	G	H	I			
Total	G		G	G	G	
U.S. Troll Fishery						
By stock		H,G[1]	I			
Total		G[1]	G	?	?	
U.S. Sport Fishery						
By stock		H,G[1]	I			
Total		G[1]	G			
Escapement Estimation						
Above Border	A,I	D,I	D,I,G	G	A[4]	G
Below Border	I		I			
Total by Stock	A,D	G	G			
Escapement Goals	D,E	D,E	D,E[2]	E[2]	E[2]	
Forecasting	D	D	G	G	G	
Fisheries Management						
In-Season Run Reconstruction						
Catch-to-Date	A	G[1]	G	T[2],G	T[2],G	
Escapement-to-Date	A	G[1]	I[2],G	G	G	
Residual Escapement	G	G[1]	I[2],G	G	G	
TAC Forecasting	A[2],G	G[1]	G	G	G	
Fishing Power Analysis	G	G[1]	G	G	G	
Information Management						
Joint or Shared Data Bases	D	H[3],D	H[3],D	D	D	D
Joint Assessment Models	A	G	G	G	G	
On-Line Access	G	G	G	G	G	
Enhancement						
Existing Facilities Doc.	A					
Feasibility Studies	A					
Monitoring Production	D					

KEY:
- ? uncertain if information gap exists
- A annual program underway
- D Developmental program to improve estimates
- E estimate exists
- G identified information gap
- H historical index program exists
- I index program in place
- T migratory timing data being recorded

NOTES:
1. when restrictions relaxed following rebuilding.
2. reliability unknown.
3. CWT data base only
4. odd year only

Table 3. Status of Alsek River salmon research and management programs in 1989. Blanks in the table mean that the information is not necessary under the guidelines of the Pacific Salmon Treaty.

	Species					
Program Element	**Sockeye**	**Chinook**	**Coho**	**Chum**	**Pink**	**Steelhead**
Run Reconstruction						
Catch Accounting						
Canadian Inriver Fisheries						
By stock	A	A	A			
Total	A	A	A			
U.S. Gill Net Fishery						
By stock	G	G	G			
Total	A	A	A	A	A	
U.S. Troll Fishery						
By stock		G	G			
Total		D,G	G			
Escapement Estimation						
Above Border	I,G	I,G	I,G			
Below Border	I^2,G	G	G			
Total by Stock	G	G	G			
Escapement Goals	E^2,D,I	E^2,G	E^2,G	E^2	E^2	
Forecasting	D,I^2	D,I^2	G			
Fisheries Management						
In-Season Run Reconstruction						
Catch-to-Date	A	G^1	G			
Escapement-to-Date	A	G	G			
Residual Escapement	G	G^1	G			
TAC Forecasting		G^1	G			
Fishing Power Analysis	G	G^1	G			
Information Management						
Joint or Shared Data Bases	G	G	G			
Joint Assessment Models	G	G	G			
On-Line Access	G	G	G			
Enhancement						
Existing Facilities Doc.						
Feasibility Studies	A					
Monitoring Production						

KEY:
- ? uncertain if information gap exists
- A annual program underway
- D Developmental program to improve estimates
- E estimate exists
- G identified information gap
- H historical data available
- I index program in place

NOTES:
1 when restrictions relaxed following rebuilding.
2 reliability unknown.

Table 4. Highly prioritized programs for filling gaps in information for the transboundary rivers with suggested study methods and estimated annual program costs.

System	Information Need	Priority	Suggested Method	Estimated Costs per Method
Stikine	Develop marine catch accounting for chinook salmon stocks	High	C,S	30-50K, 100K
	Develop marine catch accounting for coho salmon stocks	High	C,S	100K
	Improve chinook salmon escapement estimates	High	R	150-250K
	Develop coho salmon escapement estimates (in- and postseason)	High	T	80K[1,2]
Taku	Develop marine catch accounting for chinook salmon stocks	High	C,M,S	50K,10K,100K
	Improve marine catch accounting for coho salmon stocks	High	C,S	100K
	Develop chum salmon escapement estimates	Medium	T	15K[1,2]
	Improve coho salmon escapement estimates (in- and postseason)	High	T	15K[1,2]
Alsek	Improve marine catch accounting for chinook salmon stocks	Medium	C,S	30K
	Develop marine catch accounting for coho salmon stocks	Medium	C	50K
	Improve sockeye salmon escapement estimates	Medium	T or A	60K[1] or 90K[1]
	Improve coho salmon escapement estimates	Medium	?	
	Improve chinook salmon escapement estimates	Medium	R	150-250K
All	Develop on-line access for joint data base assessment models	High	?	?

KEY:
- A acoustic (sonar) estimation
- C coded-microwire-tagging
- M maturity index (gonads, scales) sampling
- R radio telemetry
- S stock identification
- T adult mark-recapture

NOTES:
[1] reduced cost per species if more than one species is tagged.
[2] estimate of escapement into Canada.

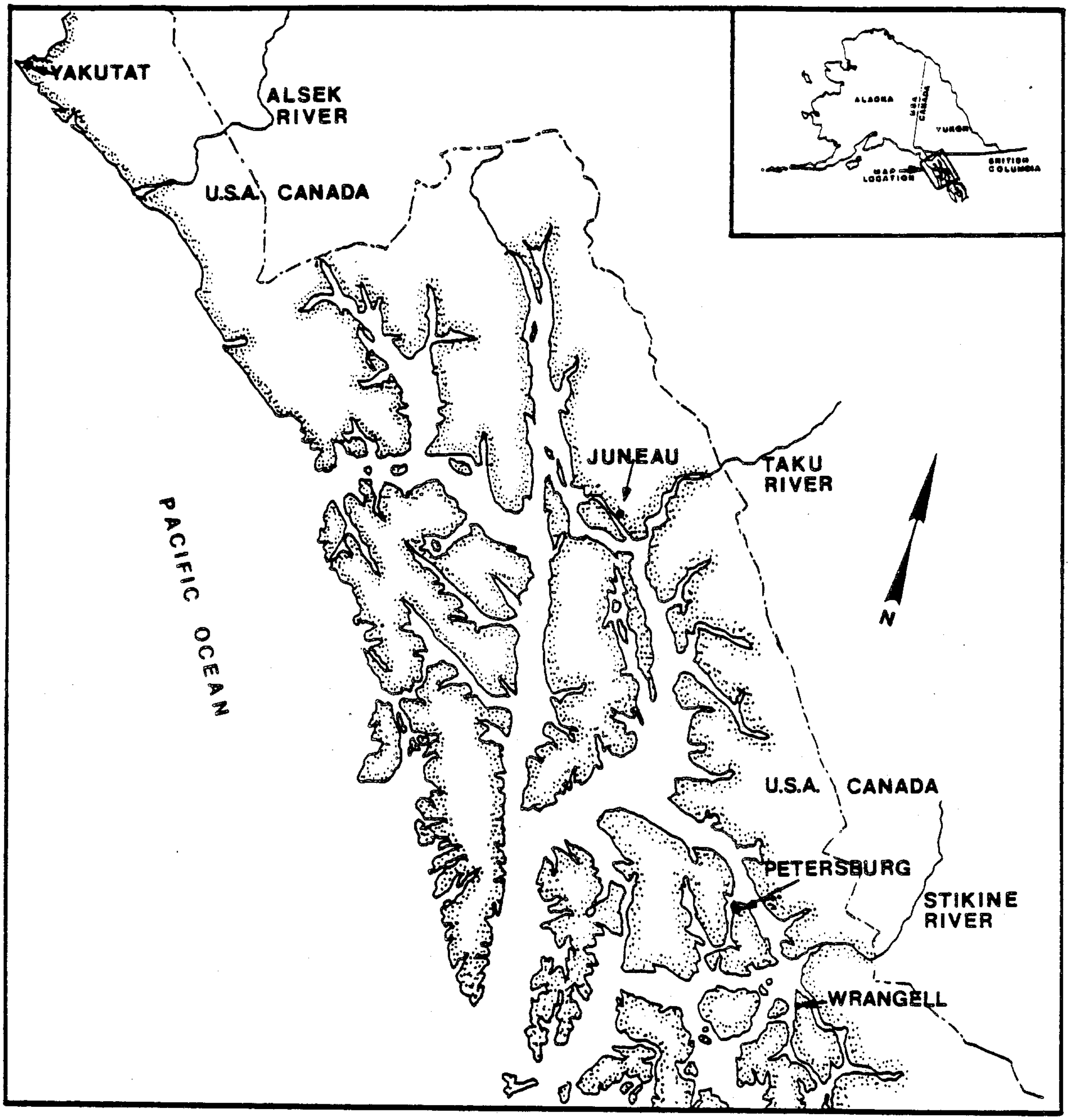

Figure 1. Southeast Alaska, northwest British Columbia and the transboundary Stikine, Taku and Alsek Rivers.

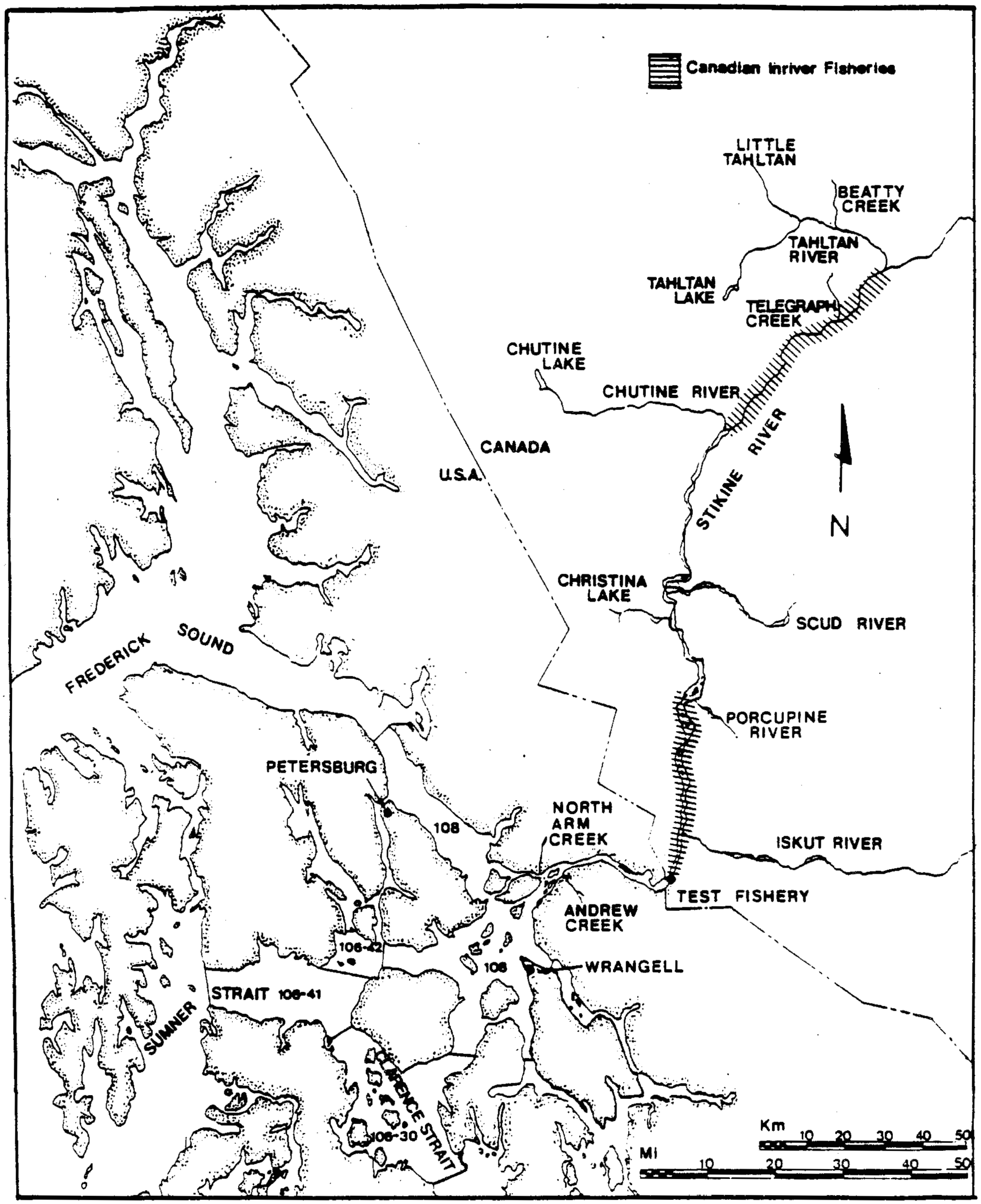

Figure 2. The Stikine River, major tributaries and fishery areas.

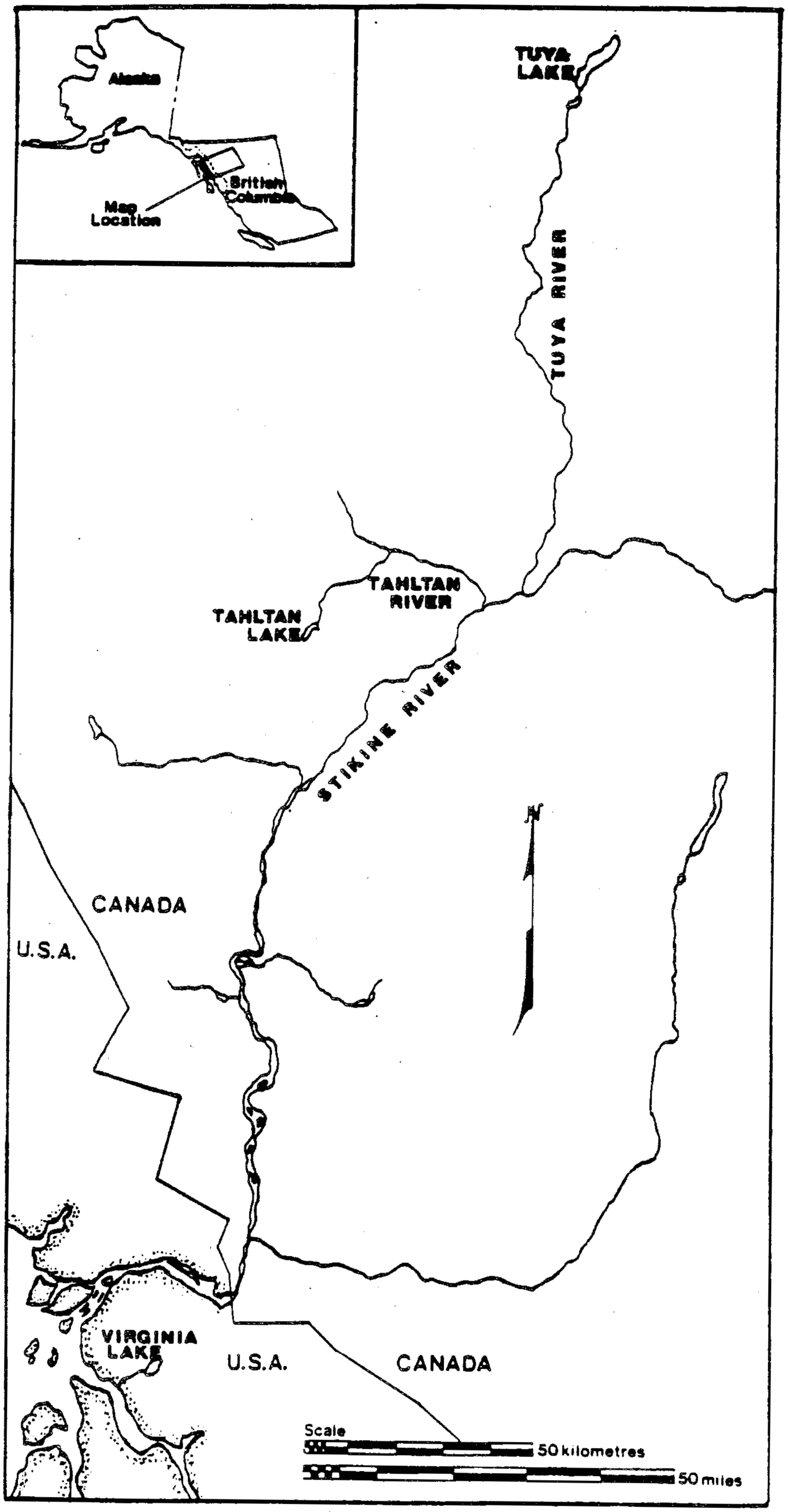

Figure 3. Stikine River and potential sites for enhancement.

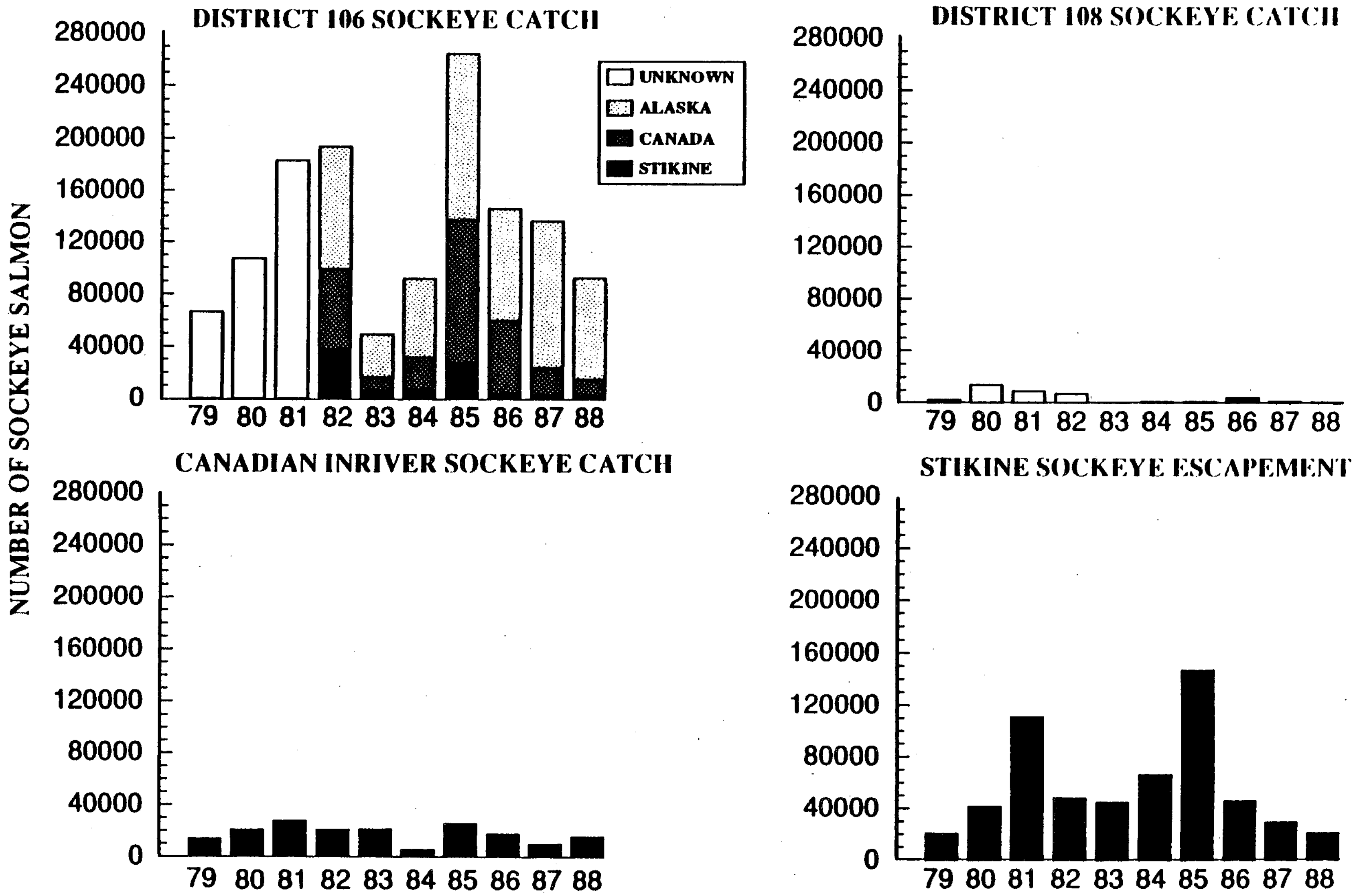

Figure 4. Sockeye salmon catches for District 106, District 108, and all Canadian inriver Stikine fisheries and Stikine sockeye escapements for 1979-1988.

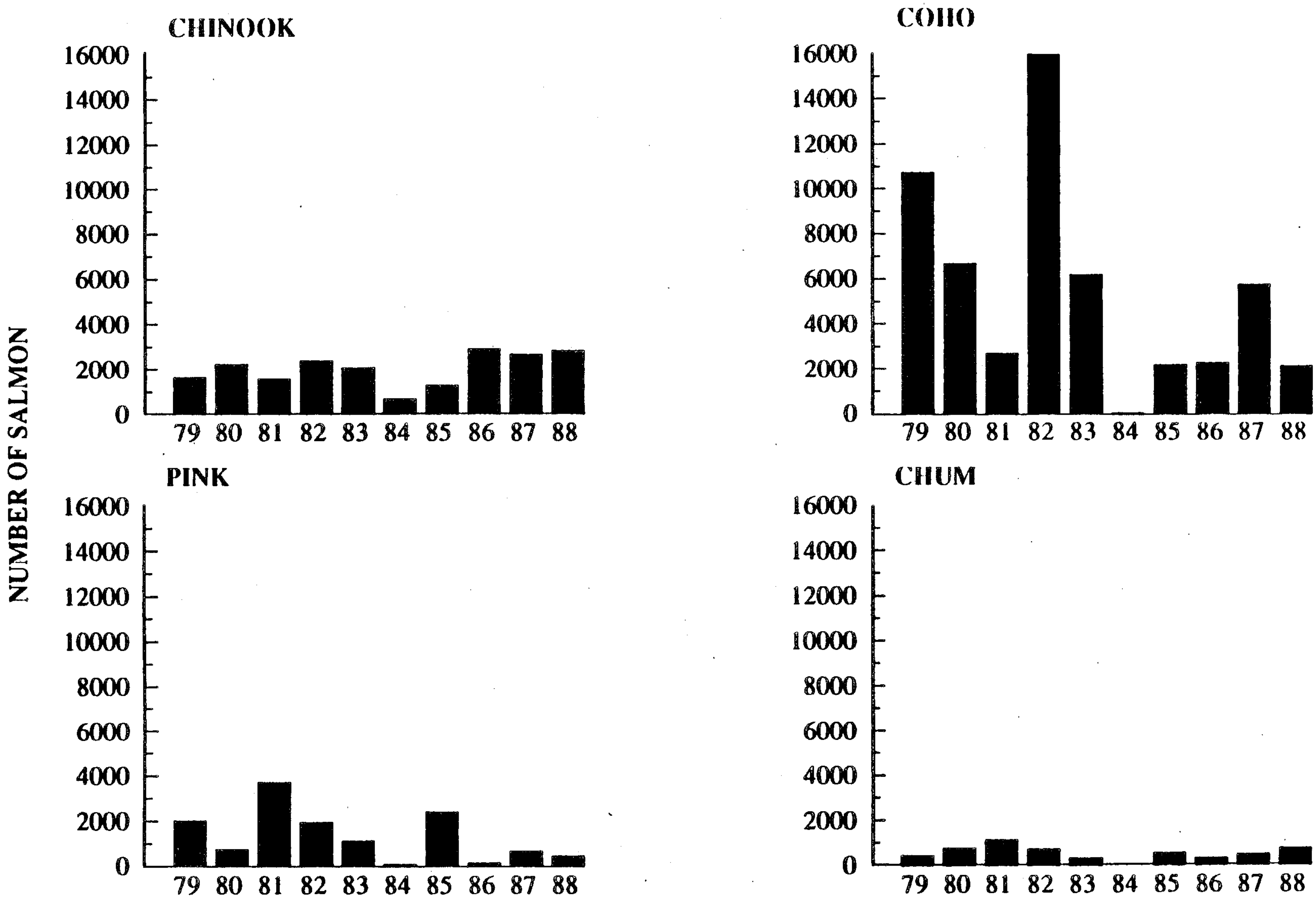

Figure 5. Catches of chinook, coho, pink, and chum salmon in all Canadian inriver Stikine fisheries for 1979-1988.

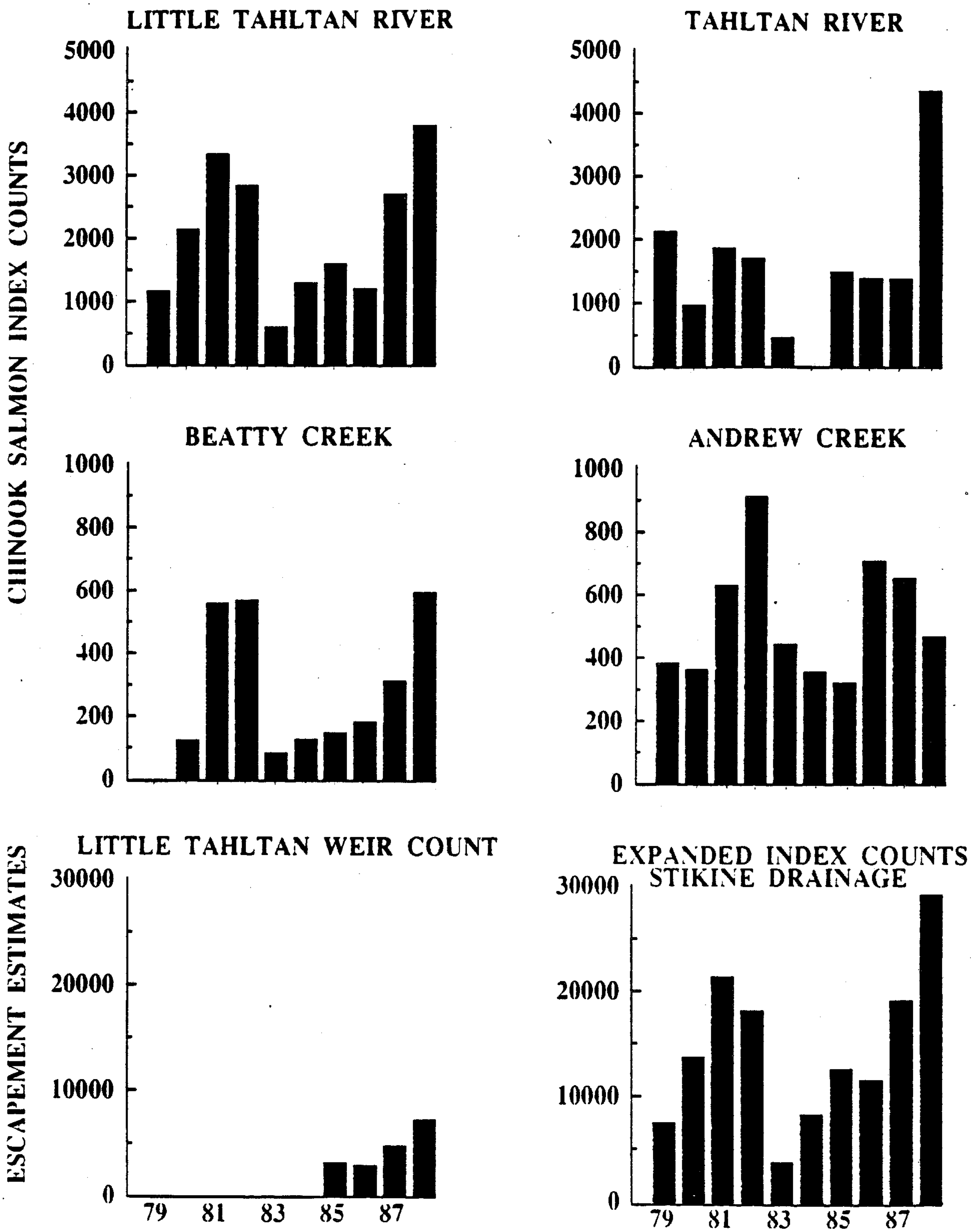

Figure 6. Peak aerial survey counts for index escapement systems, weir counts and expanded aerial survey estimates of the total Stikine River chinook escapement for 1979-1988.

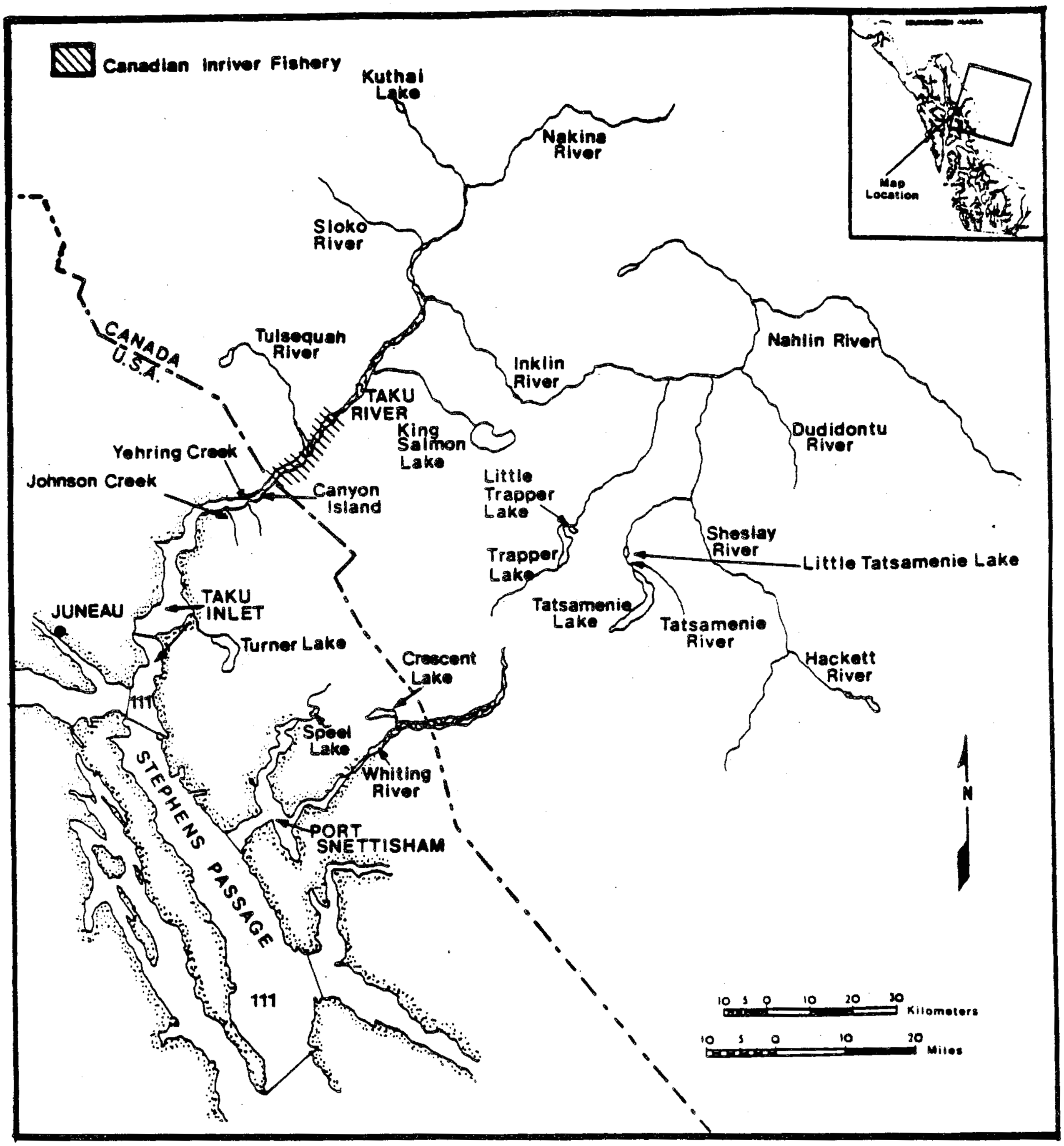

Figure 7. The Taku River, major tributaries and fishery areas.

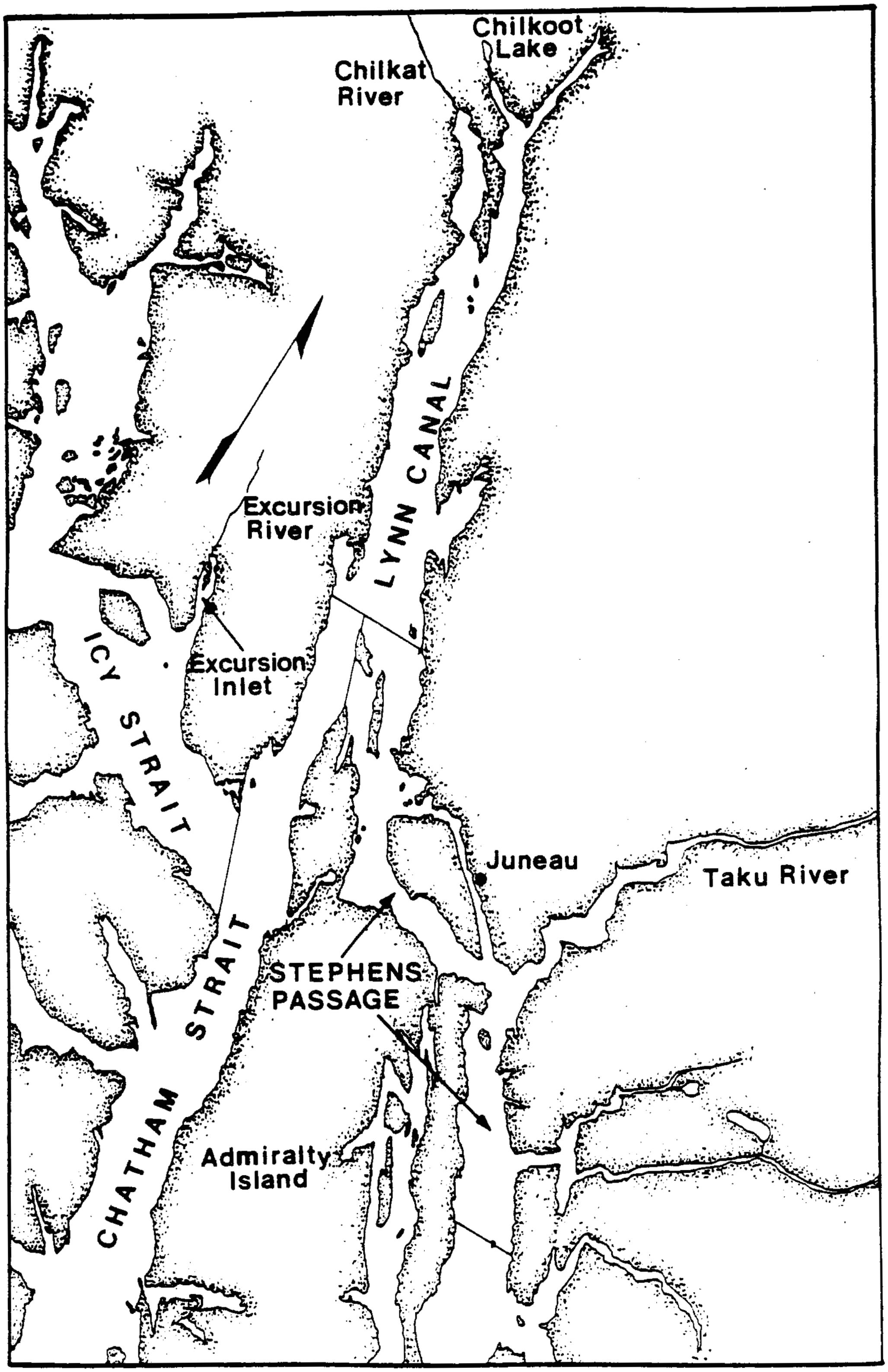

Figure 8. Principal migration corridors and river systems in northern Southeast Alaska.

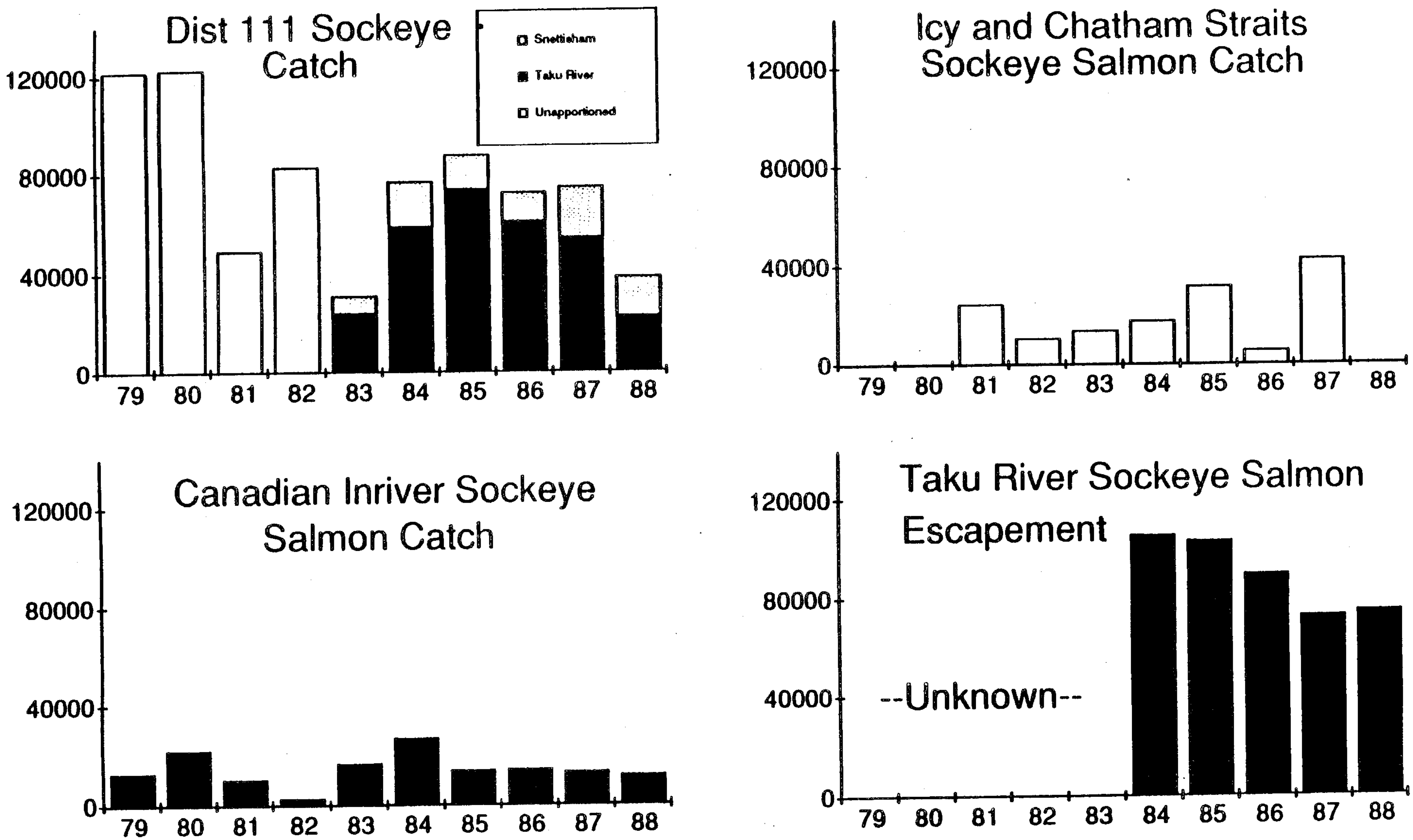

Figure 9. Sockeye salmon catches for District 111, Icy and Chatham Straits, and Canadian inriver fisheries and Taku sockeye salmon escapements for 1979-1988.

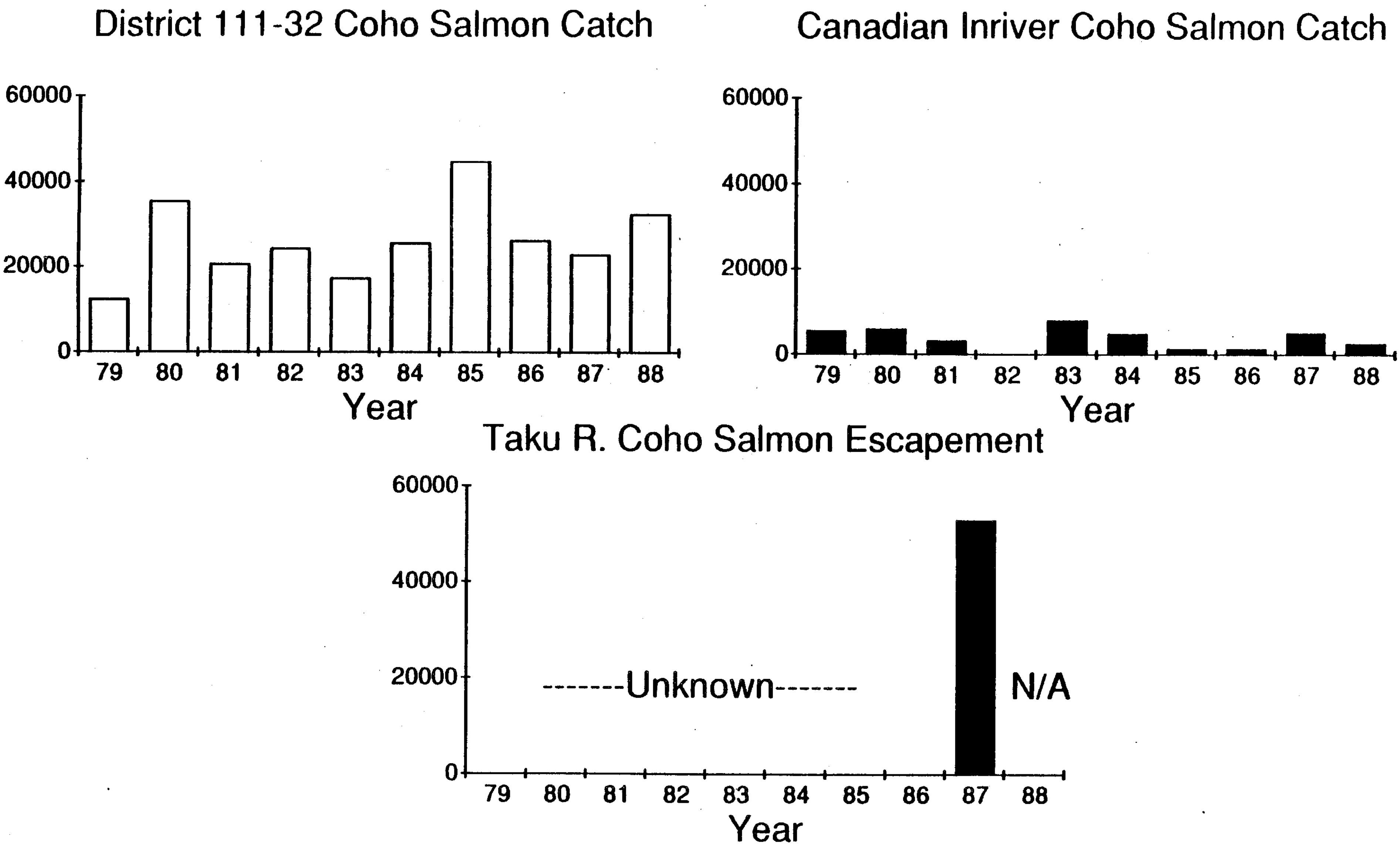

Figure 10. Coho salmon catches for Subdistrict 111-32 (Taku Inlet), Canadian inriver fisheries and Taku coho escapements for 1979-1988.

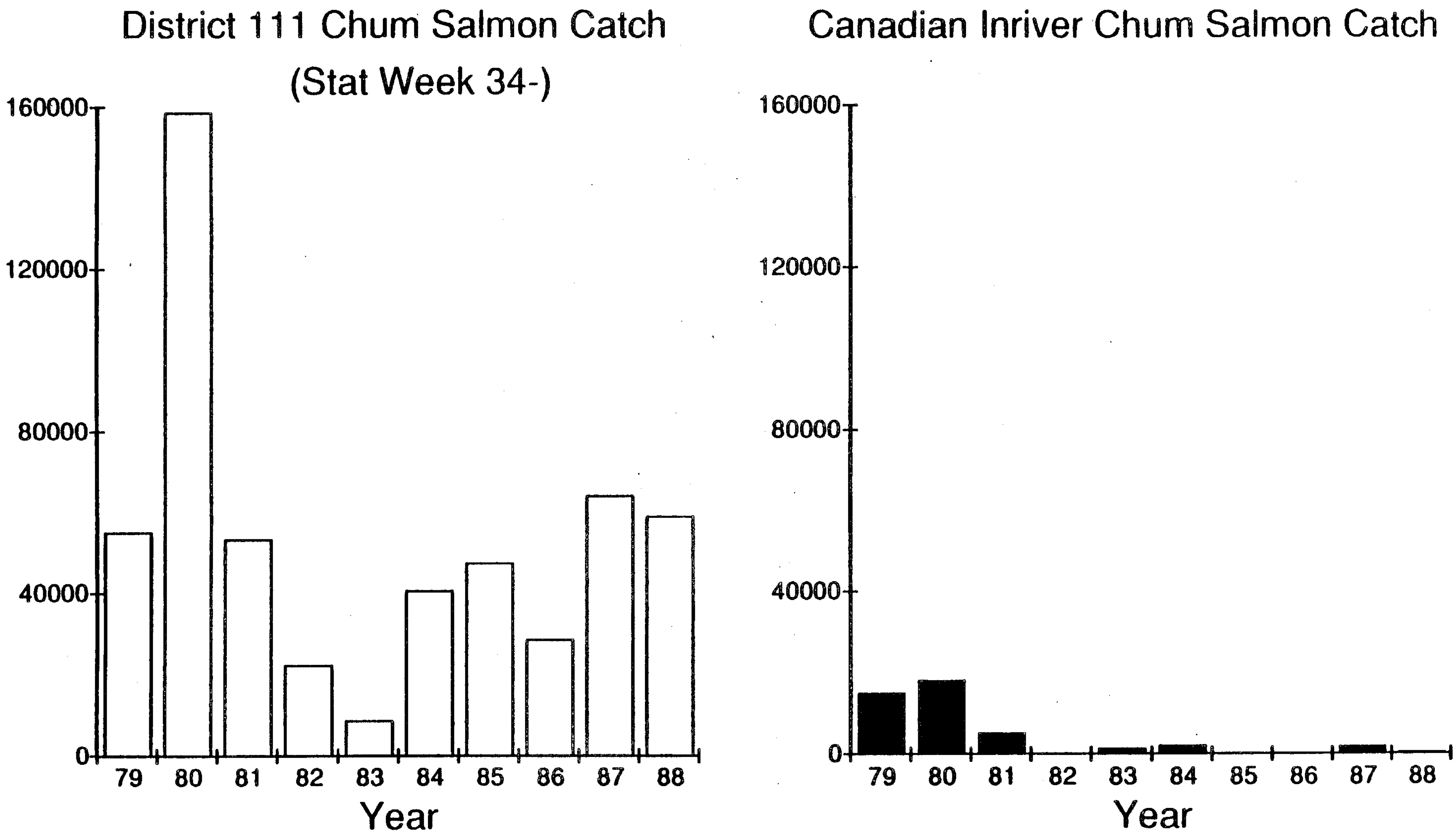

Figure 11. Chum salmon catches for District 111 after statistical week 33 and Canadian inriver fisheries for 1979-1988.

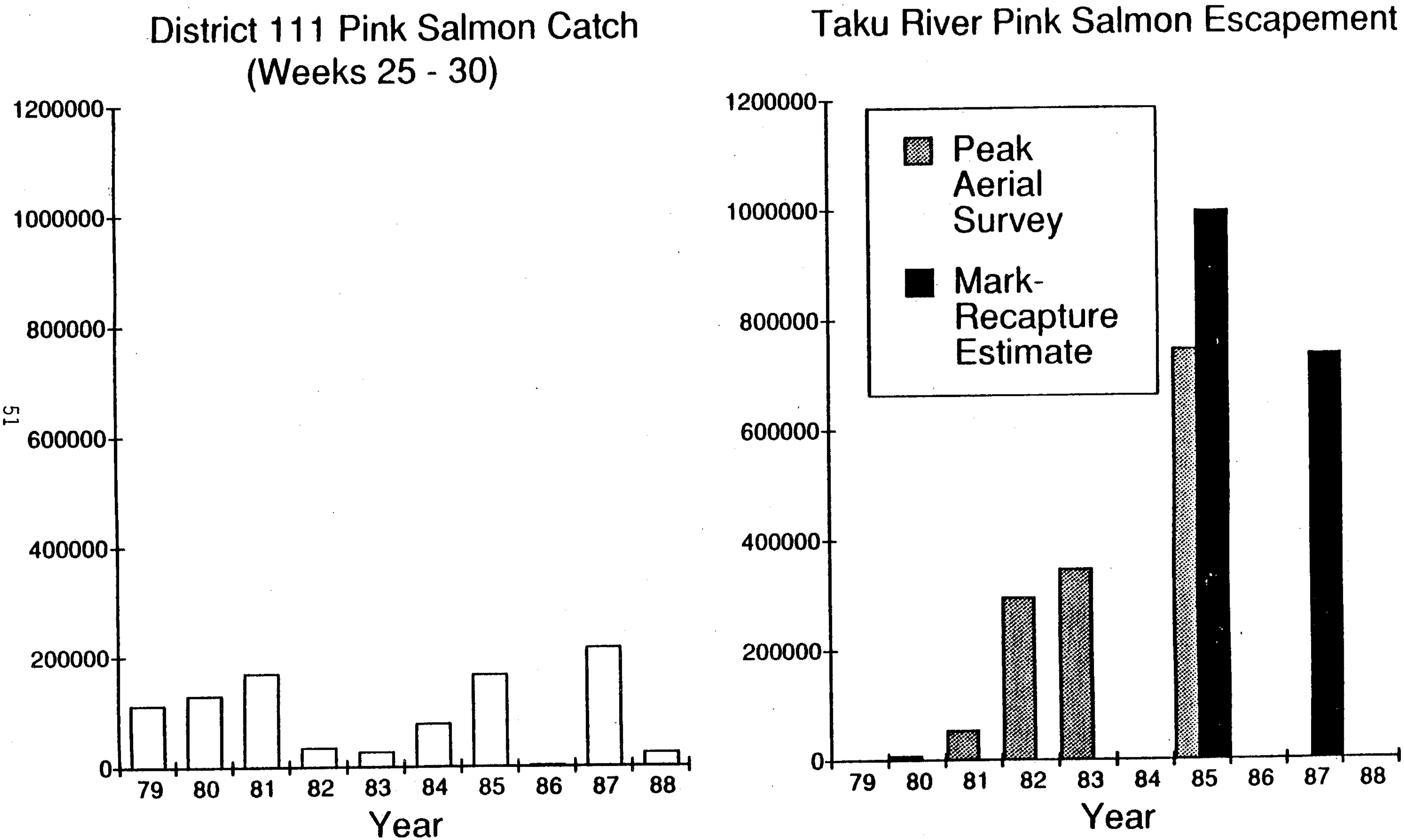

Figure 12. Pink salmon catches for District 111 during statistical weeks 25-30 and Taku pink salmon escapements for 1979-1988.

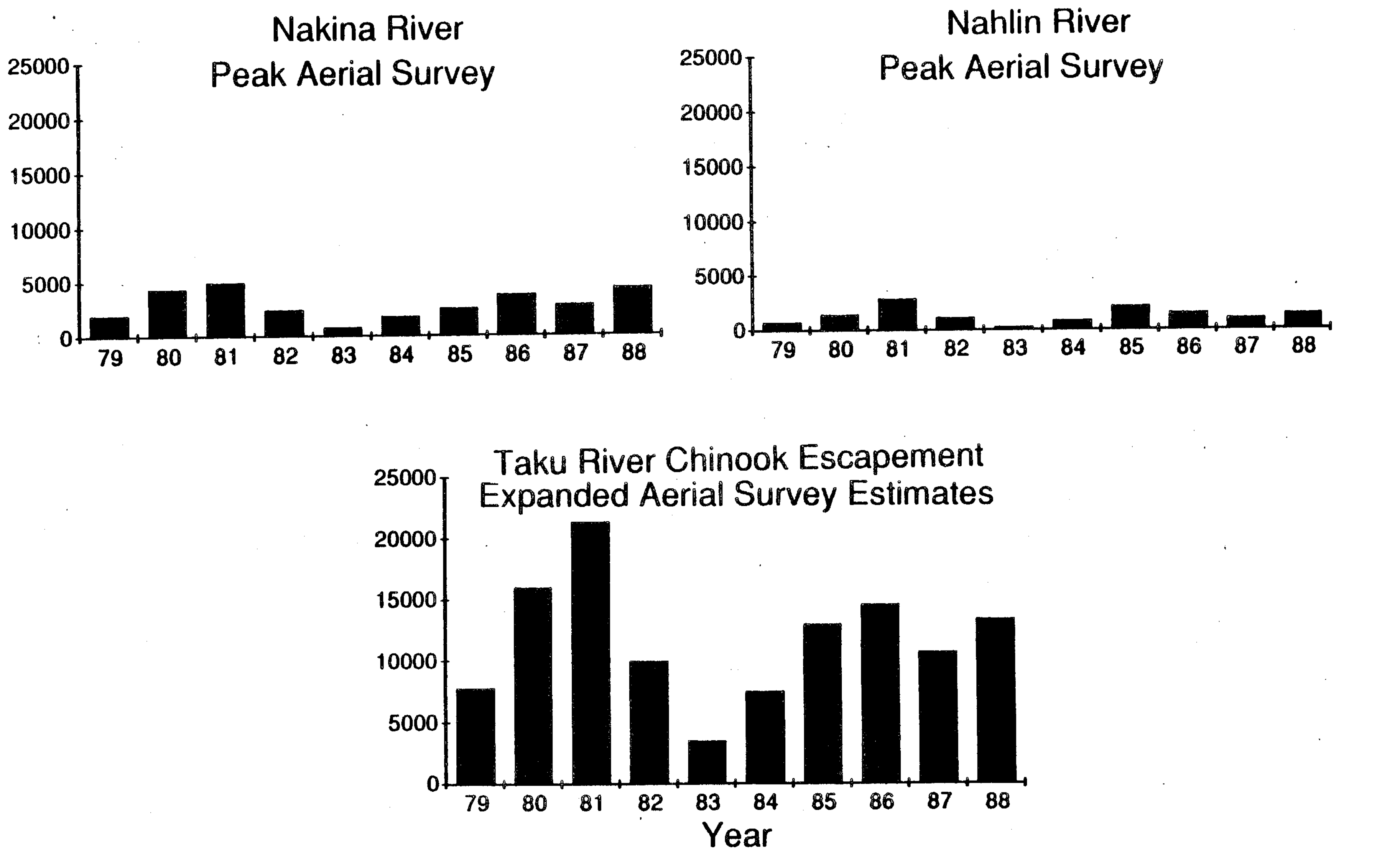

Figure 13. Peak aerial survey counts of chinook salmon for index escapement systems and expanded aerial survey estimates of the total Taku River chinook escapement for 1979-1988.

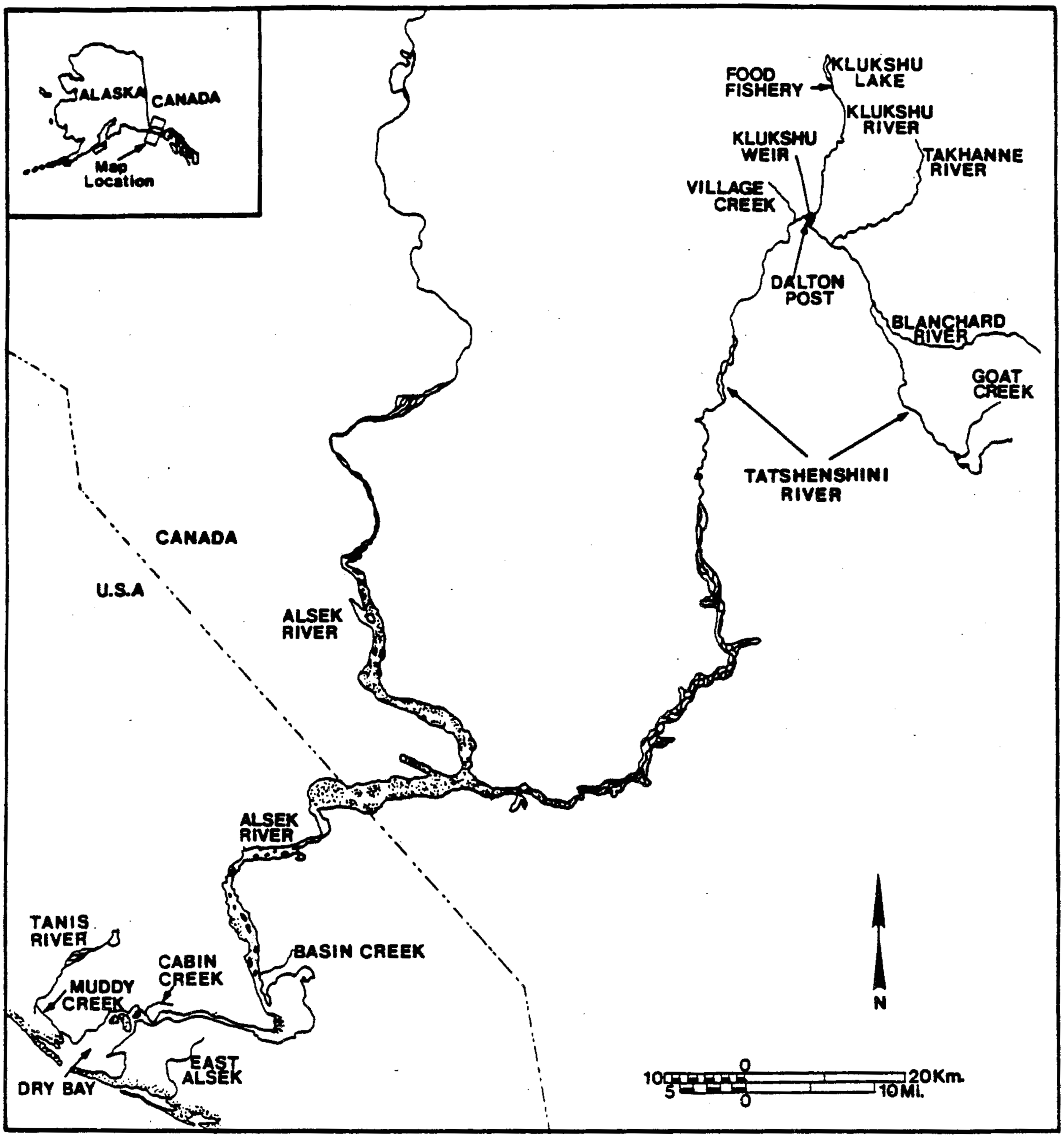

Figure 14. The Alsek River, major tributaries and fishery areas.

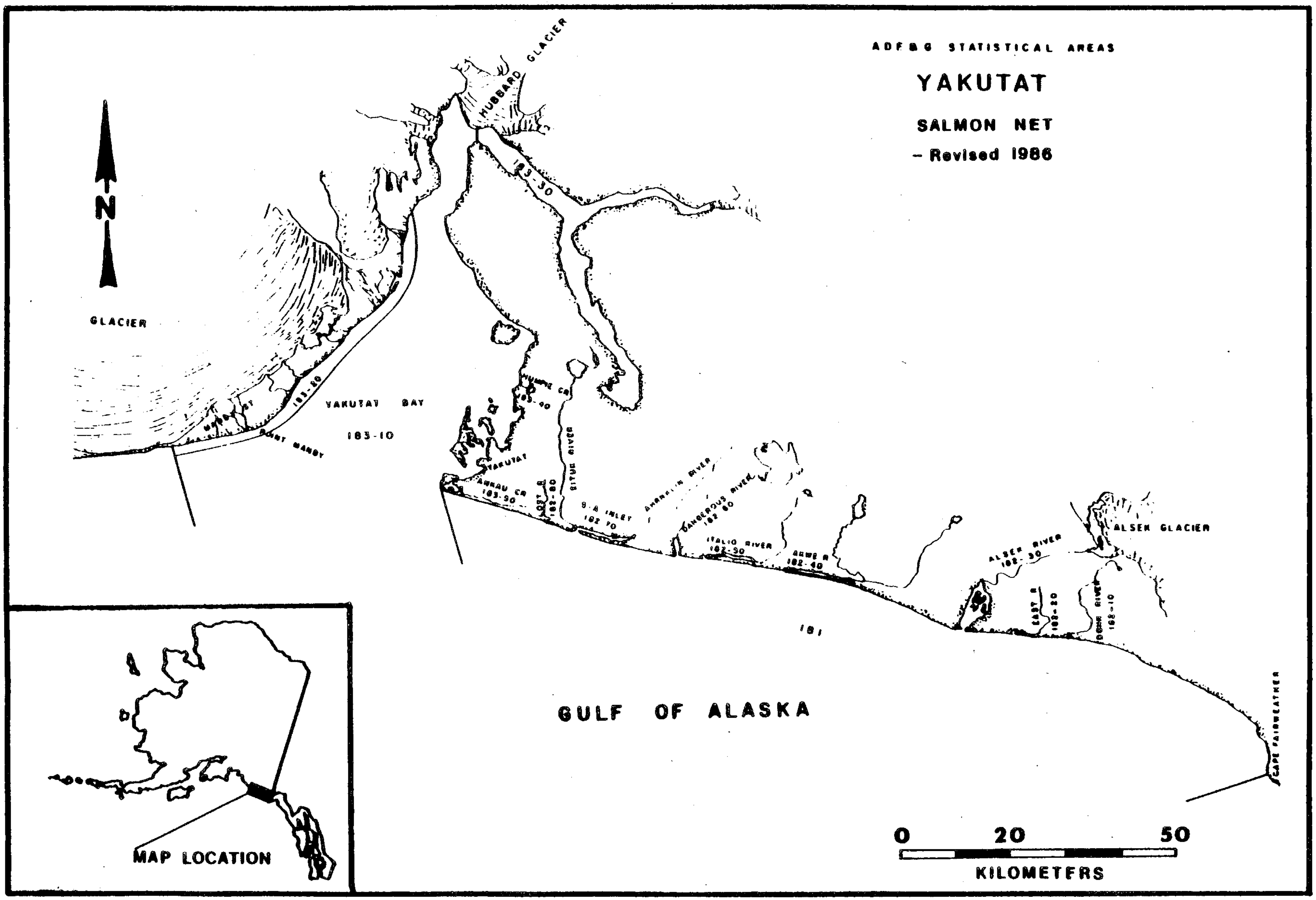

Figure 15. Yakutat, Alaska and nearby river systems and fishery areas.

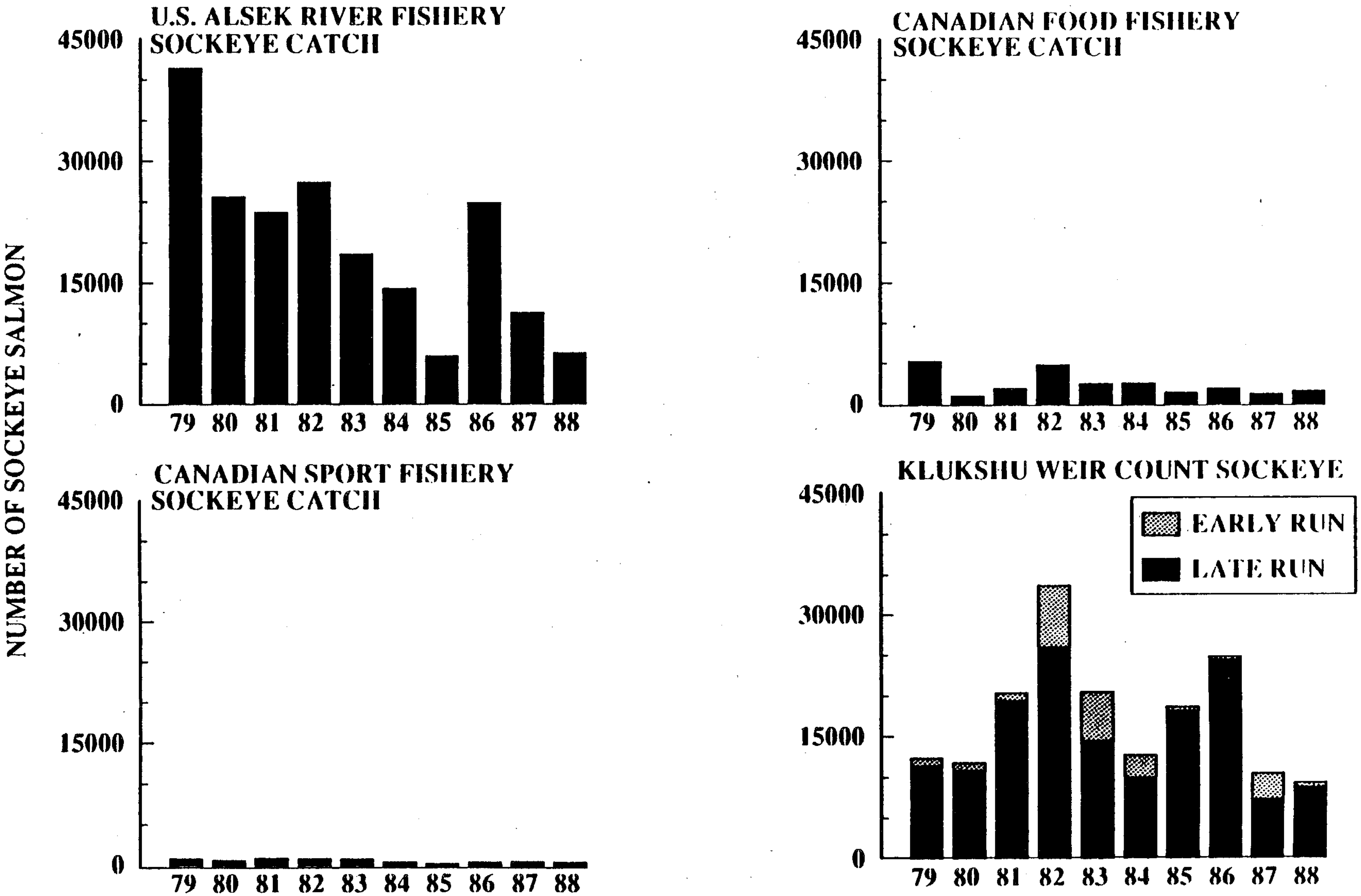

Figure 16. Sockeye salmon catches for U.S. Alsek River and Canadian inriver food and sport fisheries and Klukshu weir counts of sockeye for 1979-1988.

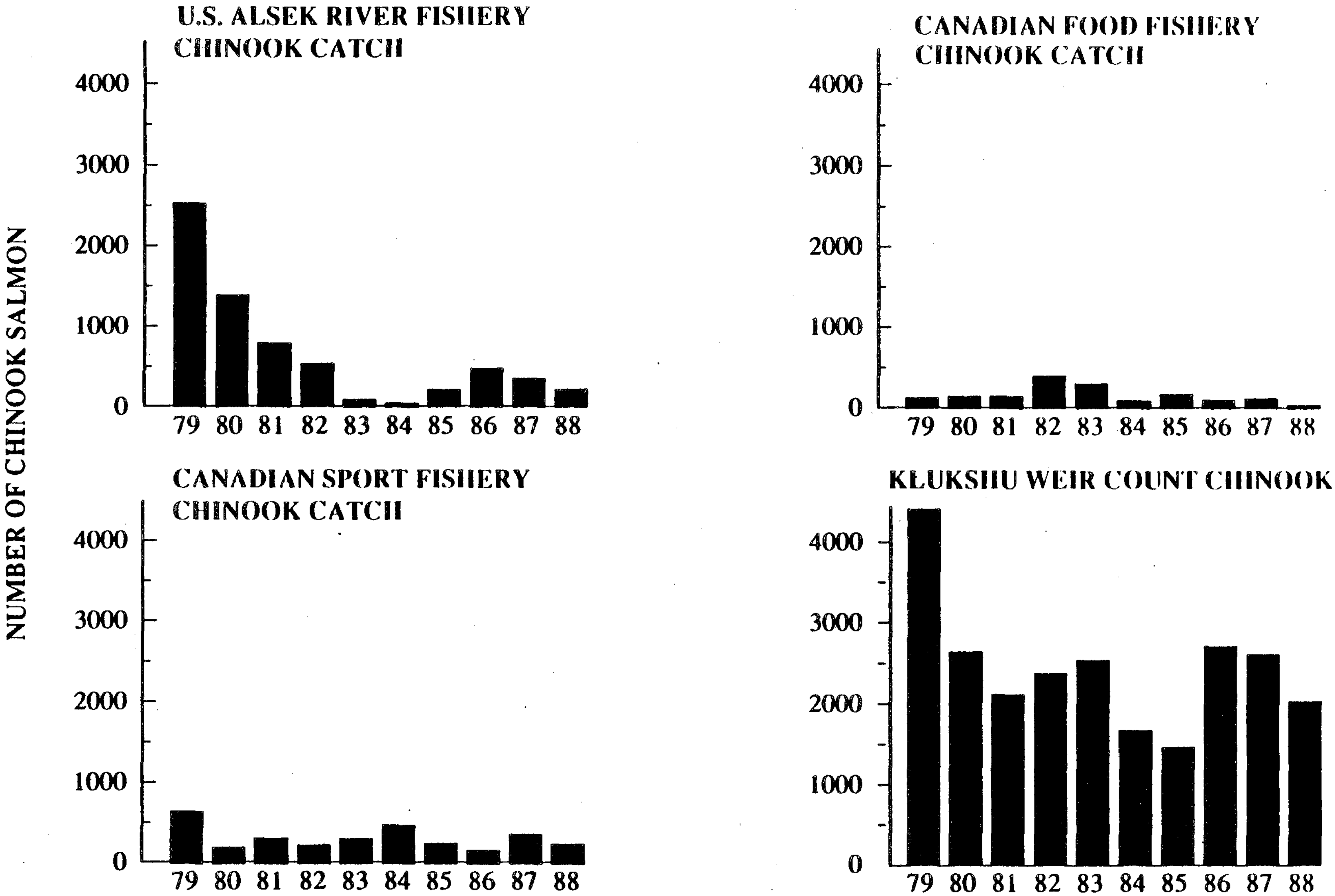

Figure 17. Chinook salmon catches for U.S. Alsek River and Canadian inriver food and sport fisheries and Klukshu weir counts of chinook for 1979-1988.

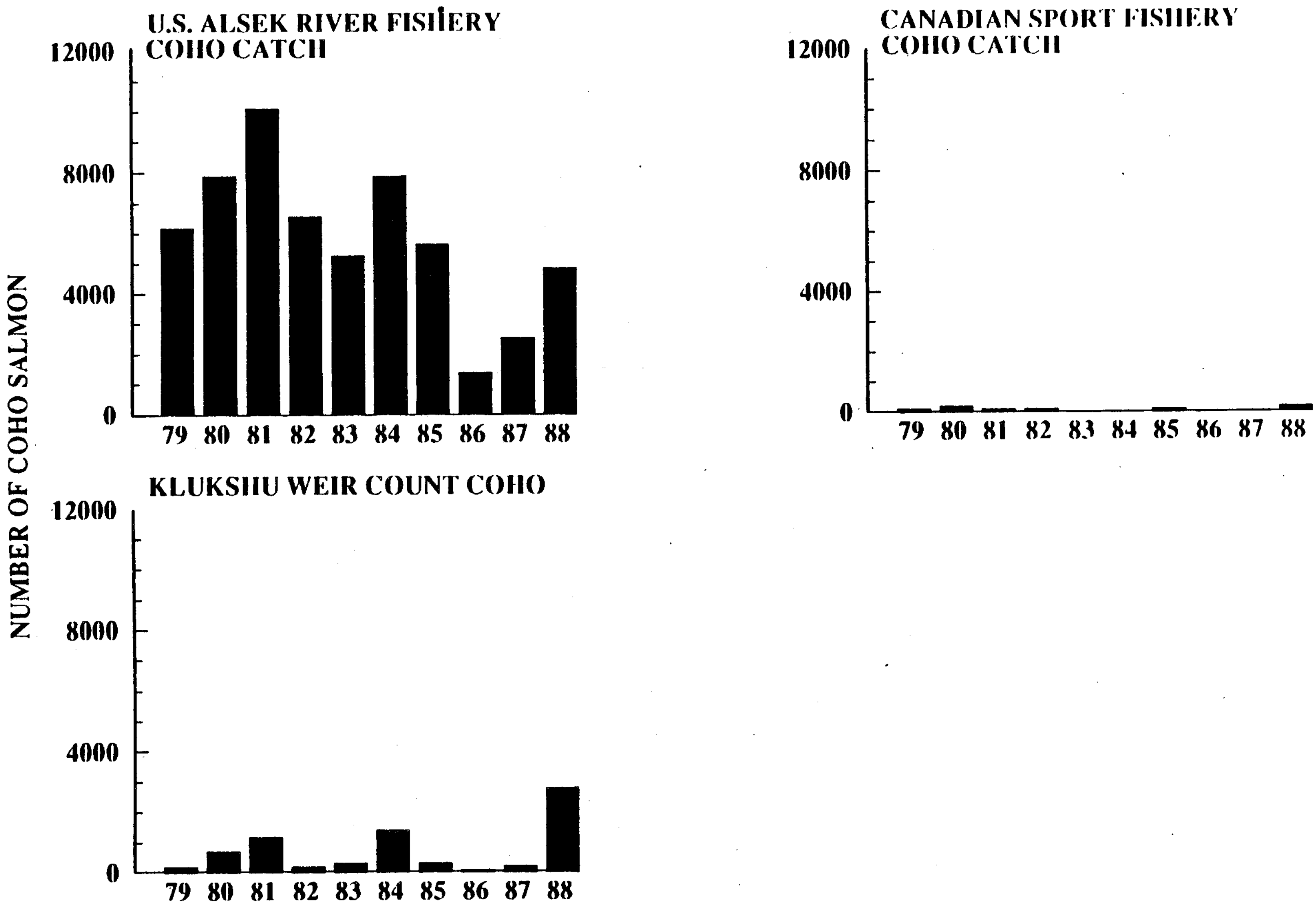

Figure 18. Coho salmon catches for U.S. Alsek River and Canadian inriver sport fisheries and Klukshu weir counts of coho for 1979-1988.